Centricast™ CL-1520, CL-2030, RB-1520, RB-2530 F-Chem™ Z-Core™

Piping Systems General Installations Instructions

Straight Socket and Butt & Wrap Joints

Fiber Glass Systems
NOV Completion & Production Solutions
nov.com/fgs

Straight Socket Joints and Butt & Wrap Joints

This fabrication manual is offered to assist you in the proper fabrication and installation procedures when assembling your Fiber Glass Systems piping system.

If you do not find the answer to your questions in the manual, feel free to contact your Regional Manager, local distributor, or the factory.

The products must be installed and used in accordance with sound, proven practice and common sense.

The information supplied in our literature must be considered as an expression of guidelines based on field experience rather than a warranty for which we assume responsibility. Fiber Glass Systems offers a limited warranty of its products in the Terms and Conditions of Sale. The information contained in the literature and catalogs furnished cannot ensure, of itself, a successful installation and is offered to customers subject to these limitations and explanations.

It is our policy to improve its products continually. Therefore, the company reserves the right, without notice, to change specifications and/or design at any time without incurring an obligation for equipment previously sold. Descriptions contained in this catalog are for the purpose of identification and neither limit nor extend the standard product limited warranty set forth in the Terms and Conditions of Sale and Trade Customs.

Installing fiberglass pipe is easier than installing carbon steel, stainless steel and lined steel due to light weight. Learning the proper methods to prepare and make-up socket or butt & wrap joints can help ensure the reliability and long-term performance of your piping system.

We offer the TQI Plus (ASME B31.3) Fabrication and Assembly certification program. Qualified Field Service Representatives train fabrication and assembly crews, conduct and supervise fabrication work, and inspect work in progress.

For complete information concerning these training seminars, contact your local distributor or Regional Manager

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SAFETY

The safety alert symbol indicates an important safety message. When you see this symbol, be alert to the possibility of personal injury

CAUTION

As this pipe may carry hazardous material and/or operate at a hazardous pressure level, you must follow instructions in this manual to avoid serious personal injury or property damage. In any event, improper installation can cause injury or damage. In addition, installers should read and follow all cautions and warnings on adhesive kits, heat packs, propane torches, etc. to avoid personal injury. Also, observe general safety practices with all saws, tools, etc. to avoid personal injury. Wear protective clothing when necessary. Make sure work surfaces are clean and stable and that work areas are properly ventilated.

Safety Data Sheets (SDS) are available on our website at www.nov.com/fgs.

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CL = Centricast Plus CL-2030 or Centricast CL-1520 Piping Systems
RB = Centricast Plus RB-2530 or Centricast RB 1520 Piping Systems
ZC = Z-Core Piping Systems
FC = F-Chem Piping Systems

Section 1

Pipe Products

Pipe Grades
Fittings
Adhesives
Fabrication Accessories
Joining Systems

Description of pipe products

The performance characteristics of a fiberglass pipe system depend on several important elements including the resin and curing agent, as well as the manufacturing process and type and thickness of the pipe's corrosion barrier.

Our piping systems are manufactured using epoxy, vinyl ester, or isophthalic polyester resin systems. All are heat cured for optimum chemical resistance and physical properties. Match your temperature, pressure and chemical resistance requirements to the piping system.

Fiberglass piping systems offers:

- Smooth iron pipe size O.D.
- Used with standard IPS pipe hangers
- High strength for long spans
- Excellent corrosion resistance
- Lightweight
- Complete line of fittings and accessories available
- Costs can be optimized by selecting pipe grades for specific services
- Full vacuum capability in premium grades
- Easy to repair if damaged

Centrifugally Cast Pipe

Centrifugally cast FRP pipe (Centricast) consists of reinforcement fabric layers saturated with thermosetting resin, then cured in a casting machine. Cast pipe features a pure resin interior barrier for maximum corrosion resistance. The glass fabric gives the pipe its structural strength and the resin provides the corrosion resistance. Pipe is available in premium epoxy (ZC), epoxy (RB) and vinyl ester (CL) resin grades.

a. Sizes 1" - 14" diameter
b. Straight socket adhesive joint method
c. No special fabrication tools required
d. 10 mil resin-rich exterior resistant to UV attack.

Filament Wound Pipe

Our filament wound pipe begins with resin-saturated fiberglass or other man-made materials as an inner liner or corrosion barrier. The liner is then covered with a resin impregnated filament wound matrix of fiberglass. The matrix is applied under controlled tension in a predetermined pattern to the specified wall thickness.

Custom Filament Wound Product

F-Chem is available in epoxy, vinyl ester, isophthalic polyester and fire retardant resin grades.

a. Sizes 1" - 72" diameter
b. Joining methods include:
- Plain end butt and wrap
- Matched tapered bell & spigot

c. No special fabrication tools required.

Pipe Grades

Centricast Plus RB-2530

Highly corrosion resistant epoxy pipe grade handles most caustics, salts, solvents, many acids and chemical process solutions up to 250°F, 100 mil pure resin corrosion barrier. Pipe has durable heavy wall construction for long spans, great impact resistance, tensile, bending and compressive strengths.

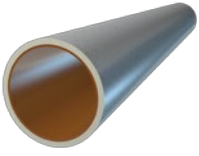
Centricast RB-1520

Epoxy pipe grade recommended for many caustics, acids, salts, solvents and chemical process solutions up to 250°F, 50 mil pure resin corrosion barrier. Pipe has long spans, integral socket joints, and low thermal expansion loads for the lowest installed cost.

Z-Core

Premium epoxy pipe with proprietary resin for outstanding corrosion resistance to aggressive solvents and strong acids, including 98% sulfuric acid. Rated for temperatures up to 275°F, 100 mil resin-rich liner. Heavy wall construction for great impact resistance, long spans and low thermal expansion.

Centricast Plus CL-2030

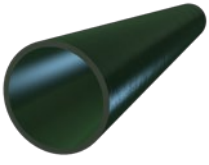


Highly corrosion resistant vinyl ester pipe grade used for over 25 years in the harshest hot acid, chlorine, and other chemical services up to 200°F, 100 mil pure resin corrosion barrier also provides impact and abrasion resistance. Pipe has high strength heavy wall construction.

Centricast CL-1520

Vinyl ester pipe grade used for many hot acid, chlorine and corrosive chemical services up to 200°F, 50 mil pure resin corrosion barrier. Long spans, integral socket joints, and low thermal expansion loads provide for a low installed cost system.

F-Chem and F-Chem AR*



Custom filament wound construction offers more flexibility in resin systems, corrosion barriers and wall thickness than our standard products. Let us assist you in selecting the right pipe for a specific application.

*AR grade is manufactured for added abrasion resistance.

Fittings

Fittings are color coded. **Epoxy Fittings:** RB fittings are brown; Z-Core fittings are dark green or black. **Vinyl Ester Fittings:** CL fittings are off-white. Be sure to use the correct grade of pipe and fittings for your service. Consult Bulletins for pressure rating limits on various fittings. Be sure your system pressure requirements do not exceed the lowest rated component fittings.

Most compression-molded fittings have a center line dot or cross which will assist you in making measurements. Take-off dimensions for most standard fittings are shown in Tables 6-8 on starting on page 30. The positive stop or "land" in the socket helps you make exact fabrications.

Photo 1
Fittings

Adhesives

Adhesives are formulated for specific use with the companion pipe grades. Use only the recommended adhesive with each pipe grade - do not mix systems! Standard adhesives are a two-component system (Parts A and B) which must be mixed prior to use. CL-200 Quick Set (QS) adhesives are available for reduced cure time where necessary. **Detailed instructions for adhesives are provided with each kit**. Read these instructions thoroughly and follow the recommended procedures. The pot life and cure time of the adhesive is dependent on temperature; refer to pages 13,14 and 49. Ambient temperatures above 100°F require extra care by the fabricator to assure sufficient working time of the adhesive. Refer to Adverse Weather Recommendations on page 20.

Adhesive Selection

Standard adhesive kits are designed to be used with specific piping systems as shown in Table 1.

Table 1

Adhesive Selection
Standard adhesive kits are designed to be used with specific piping systems as shown below

Use with these Piping Systems	Kit Number[1][2][3]	Maximum Service Temperature
Z-Core	Weldfast™ ZC-275	275°F
Centricast Plus CL-2030 & CL1520	Weldfast CL-200	200°F
Centricast Plus CL-2030 CL-1520	Weldfast CL-200 QS[4]	200°F
Centricast Plus RB-2530 & RB-1520	Weldfast ZC-275	250°F
F-Chem	Vinyl Ester, Butt Weld Kit	250°F

NOTES:

1. Although all of the adhesives will cure at ambient temperatures above 70°F, it is mandatory they be heat-cured at temperatures of at least 275°F to maximize physical properties and corrosion resistance. See pages 38-42 for instructions for using heat blankets or collars for heat-curing joints.
2. For complete detailed instructions on using adhesive, refer to the step-by-step instruction bulletin included in the adhesive kits.
3. Refer to Chemical Resistance Guide, for adhesive chemical resistance rating.
4. Quick-set adhesive for use when faster cure time is required and the ambient temperature is below 90°F. Weldfast CL-200-QS is the same as Weldfast CL-200 except a third component, Part C, has been added to the kit.

Adhesive Working Life

Working life or pot life is the time it takes for the adhesive to harden in the mixing can. Refer to Table 2.

Table 2

Adhesive Estimated Pot Life

Pipe Resin Systems	Adhesive	Pot Life @ 70°F (min.) (see note)	Pot Life @ 90°F (min.) (see note)
Epoxy	275	30-40	15-25
Vinyl Ester	200	20-30	6-12
Vinyl Ester	200QS	7-15	4-7
Vinyl Ester	Butt Weld*	20-40	8-15

NOTES:

Pot life or working life is the time available for fabrication. Times may vary depending upon temperature, humidity, etc.

* Based on 16 ml of catalyst per quart of resin.

Table 3

Approximate Number of Bonds per Kit

	Pipe Size									
	1	1½	2	3	4	6	8	10	12	14
Number of Joints	12	10	8	5	3	2	1	1/2	1/2	1/2

Fabrication Accessories

Heat Collars and Heat Blankets

Silicone heat blankets and high temperature heat collars are offered for use in curing of adhesive socket joints. The blankets and collars have a pre-set thermostat which controls the temperature of the unit. See pages 38-39 for instructions and cure times for adhesive joint fabrications.

Photo 2
Heat Blanket

Heat Gun

High wattage electric heat guns are also available to heat adhesive joints. The heat guns are 1600 watt capacity.

Photo 3
Heat Gun

Joining Systems

Socket Joint

Straight socket adhesive joints have positive stop lands for precise makeup.

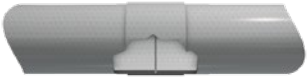


Figure 1
Socket Joint

Butt & Wrap Joint

Two pieces of plain end pipe or pipe and fittings are butted together, then several layers of resin saturated mat or woven roving are wrapped around the area and cured. Highly reliable joint in critical service applications.

Figure 2
Butt & Wrap Joint

Section 2

Site Considerations

Storage and Handling
Tools, Equipment and Supplies
Adverse Weather Conditions
Buried Recommendations
Anchors, Guides and Supports
Cutting Pipe
Assembly Layout
Take-Off Dimensions

Site Considerations

Storage and Handling

Pipe and Fittings

Fiberglass reinforced pipe, fittings, and adhesives require special storage and handling. Care should be taken in transporting, unloading, handling, and storing products to prevent impact and other damage.

When transporting pipe, the spacers under and between the pipe joints must be of sufficient width to avoid point loading, which could produce cracking or buckling damage. A minimum of four spacers should be used for supporting 14" and larger 40' long pipe joints. More spacers should be used for smaller pipe or if pipe is stacked over eight feet high.

Due to its light weight, lifting equipment is usually not required for 1" - 14" pipe. When lifting equipment is required, use nylon slings or chokers. Do not allow chains or cables to contact the pipe during transport or handling. If a pipe or fabrication is more than 20 feet long, use at least two support points.

For storage, a board (2 x 4 minimum) should be placed under each layer of pipe approximately every five feet. The intent is to support the pipe and distribute the load evenly. The pipe should also be braced on either side of the pipe rack to prevent unnecessary pipe movement. Avoid placing pipe on sharp edges, narrow supports, or other objects that could cause damage to the pipe wall. When storing pipe directly on the ground, select a flat area free of rocks and other debris that could damage the pipe.

Pipe is furnished factory packaged in compact, easy-to-handle bundles complete with protective end caps. Leave these caps in place until installation time to protect the pipe ends as well as to prevent dirt or other material from getting into the pipe. Fittings are packaged in cardboard boxes and should be stored in a dry area. If fittings are removed from the boxes, protect machined bells and spigots from exposure to direct sunlight.

Pipe can be damaged when joints or bundles of pipe are dropped during handling or shipping. Severe localized impact blows may

result in damage to the fiberglass reinforced structure in the pipe wall. **Before installation, inspect the pipe's outer surface and inner surface (if possible) for any damage.** Do not use damaged pipe unless inspected and approved by a company representative. If impact damage occurs, the damaged areas may be recognized by a star type fracture on the interior of cast pipe or the exterior of filament wound pipe. Pipe that has been damaged should have a length cut away approximately one foot either side of the damaged or cracked area.

NOTE:

Do not allow the bell end of the pipe to support any pipe weight.

Do not allow deformation of the pipe due to supports or straps.

Adhesive

We recommend adhesives be stored in a dry area where temperatures do not exceed 80°F. Refer to adhesive instructions included in each kit for storage life recommendations. Vinyl ester adhesives are particularly susceptible to damage caused by high temperature storage.

Tools, Equipment and Supplies

Requirements for Installation

For maximum efficiency, the following tools and equipment are recommended prior to any installation:

- Fab Tables, Pipe Stands, Jacks & Vice
- Hand Tools
  - Level, Marking Pen, Tape Measure, Pipe Wrap
  - Hacksaw (22-28 teeth/inch)
- Power Tools
  - 1" or 2" drum sander
  - Disk sander
  - Circular power saw with a grit edge abrasive blade, aluminum oxide, carbide or diamond.
  - Band Saw with 16-22 teeth/inch at speeds of 200 - 600 ft./min.

- Saber saw with carbide-tipped blade
- Chop saw with aluminum oxide blade
- Heat gun and heat blanket may be required

- Expendables
  - Impermeable Gloves
  - Chemical Splash Goggles
  - Clean, Dry, Lint-Free Shop Cloths
  - Sandpaper Disc/Emery Cloth (36-60 grit)

NOTE: We suggest securing an area where work can be planned, staged, and quickly executed more efficiently. Power tools greatly reduce the time required to sand pipe and fittings prior to bonding.

Equipment for Cool Weather pipe assembly (Below 70°F):

- Heat source
  - Portable torch with spreader tip, or
  - Portable electric heat lamp, or
  - Industrial hot air gun
- A means of maintaining adhesive kits at 70°-80°F:
  - A box with a 25 watt light bulb, or
  - Inside of a warm vehicle with the heat running.
- Heat assisted curing
  - Electric heating collars or blankets
  - Chemical heat packs

WARNING: Be sure there are no flammable material or gas present when using any type of heating device.

Recommendations for Fabrication in Adverse Weather Conditions

FRP piping can be installed in adverse weather conditions when the necessary precautions are taken. Actual work will often be more quickly completed in high temperature conditions. Low temperatures can increase the work time 20%-35% over normal shop conditions. A similar increase is common for high moisture conditions.

Hot Weather Installation Tips

Hot weather conditions, temperatures above 90°F, will greatly reduce the working time of the adhesive. The following steps are recommended when fabricating in hot weather conditions:

1. Avoid direct sunlight on the joining surfaces.
2. Store adhesive in a cool area.
3. Keep mixed adhesive in an ice chest with sealed bag of ice or ice pack.
4. Refer to the field fabrication instructions supplied in adhesive kit for the proper amount of catalyst in vinyl ester kits.
5. Butt weld laminates must be "staged" by applying no more than four layers of fabmat at a time. Staging prevents excess exothermic heat. Sand the bonding surface after each stage has gelled and cooled to less than 120°F.

Cold Weather Installation Tips

Adhesive cure time is directly related to the temperature. Colder temperatures result in longer cure times.

The following steps should be used when fabricating in colder temperatures:

1. Adhesive kits should be placed in a warm room for six to twelve hours before application in order to reach temperatures of 80°F -100°F. This will make mixing much easier and speed cure times. Or use a box with a 25 watt light bulb to warm adhesive kits.

2. When possible, piping should be bonded indoors into sub-assemblies. The warmer conditions of these areas will allow faster cure times.
3. Pre-warm bonding surfaces to 80°F -100°F when temperature falls below 70°F.
4. Refer to the field fabrication instructions supplied in the adhesive kit for the proper amount of catalyst for vinyl ester kits.
5. A heat gun, collar or blanket may be used to obtain a faster cure time. Apply a layer of fiberglass insulation or a welding blanket around the heat collars or blankets when installation temperatures are below 50°F.

Extreme Moisture

Adhesive Joints

- If fittings or pipe have moisture on the bonding surface, wipe them dry prior to sanding.
- Sand pipe or fittings immediately before applying the adhesive to bond the joint. Sand surfaces until a fresh, dry surface is present, then remove dust with a clean dry cloth, and apply adhesive.
- Cure per the previous recommendations for normal, extreme heat or extreme cold temperatures.

Laminate Joints

- Keep the glass fabric dry, as resins will not saturate wet fabric. Discard glass fabric which has been wet or exposed to rain, as moisture can remove the bonding agent.
- In high humidity environments, keep the glass fabric in the plastic wrap until ready to use.
- If it is raining, move the work to a shelter, or construct a temporary shelter.
- Bonding surfaces must be sanded immediately prior to application of the resin to the pipe or fitting. Sand or grind until a fresh, dry surface is present, then wipe off the dust and apply resin.

- Saturate the fabric with the resin and apply a coat of resin to the sanded surface prior to applying the fabric.
- Refer to recommendations for conditions of extreme heat, cold, or normal conditions for curing.
- When a laminate requires staging, repeat the above precautions for each step.
- Moisture will not affect the cured laminate joint.

Burial Recommendations

These are general guidelines only. For more details see Engineering and Piping Design Guide.

Burial Depth:

Minimum burial depth in unpaved areas for pipe subjected to vehicular loads depends on pipe grade, pipe size, vehicle axle weight, and the bedding material. Depths for axle loads of 34,000 lbs., minimum depth of cover (from the top of the pipe to the surface) and moderately compacted non-clay bearing soils is shown in Table 4.

The pipe should always be buried below the frost line.

Maximum burial depth is dependent on the backfill material. For moderately compacted soils that do not contain large amounts of highly expansive clays, the maximum burial depth is shown in Table 4.

Trench Preparation - Final bedding of the trench must be as uniform and continuous as possible. Before backfilling, fill all gaps under the pipe with proper bedding material. Avoid sharp bends and sudden changes in slope. It is important to remove all sharp rocks, cribbage, or other foreign objects that could come in contact with the piping.

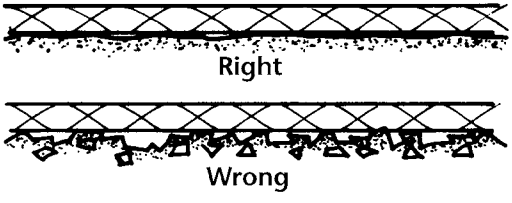


Table 4

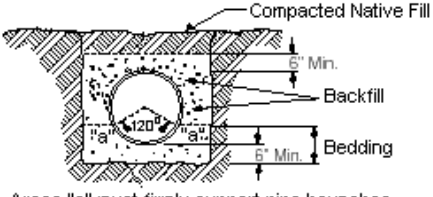
Burial Depths*

Product	Minimum		Maximum	
	ft	m	ft	m
Centricast CL-1520	2	0.6	20	4.6
Centricast CL-2030	2	0.9	20	4.6
Centricast RB-1520	2	0.6	20	4.6
Centricast RB-2530	2	0.9	20	4.6
Z-Core	2	0.6	20	4.6
F-Chem Custom Piping**	3-5	0.9-1.5	12-20	3.7-4.6

* Based on a 1000 psi composite constrained modulus. Contact the factory for detailed information for your specific application.

** F-Chem is designed for specific burial applications according to AWWA M45

Bedding Requirements - Fiberglass pipe can be damaged by point contact or wear with the trench bottom and walls, improper bedding materials, or adjacent pipe. Use recommended bedding material a minimum of 6 inches thick at the bottom, sides, and top of the piping (refer to Table 4). Adjacent pipes should be spaced the greater of 6 inches or one pipe diameter. The piping can be laid directly on the trench bottom if the native soil meets the requirements of a recommended bedding material (refer to Table 5). In some situations, the trench bottom can be "scratched" such that a natural cradle of dirt is formed. Never lay fiberglass piping directly against native rock or shale. Always use dry, unfrozen bedding materials that do not contain foreign objects or debris. Never use water flood for compaction. Slurries can be used that are intended for burial of flexible piping systems. When using slurries, care must be taken to prevent floating or deformation of the piping.



Areas "a" must firmly support pipe haunches

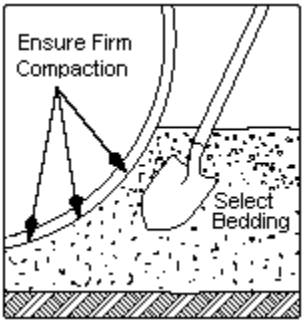
Table 5

Recommended Bedding Materials

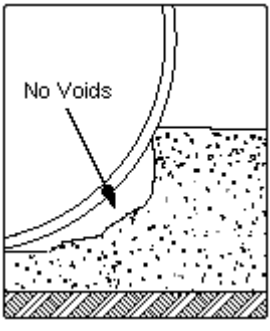
Bedding Material	Compaction Proctor Density
Crushed rock or pea gravel 3/4" maximum size	Not Required
Coarse-grained sand or soil with little or no fines	75-85%
Coarse-grained sand or soil with more than 12% fines	85-95%
Sand or gravel with more than 30% coarse-grained particles	85-95%
Sand or gravel with less than 30% coarse-grained particles	Greater than 95%

Pipe Support - Fiberglass pipe is flexible and requires the support of the bedding material to keep the pipe round in burial applications. It is very important that a recommended bedding material is properly compacted around the entire circumference of the pipe. (Refer to Table 5) Tamp the bedding material under the bottom half of the piping to prevent voids or areas of low compaction. Vibratory or similar tamping equipment can drive small stones or debris into the pipe wall if they are present in the bedding material. Avoid striking the pipe with tamping equipment as the pipe may be fractured.

High Water Tables or Vacuum - Consult factory for recommendations.

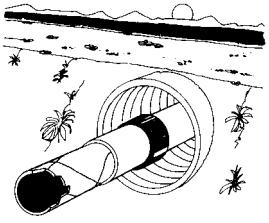


Proper Bedding



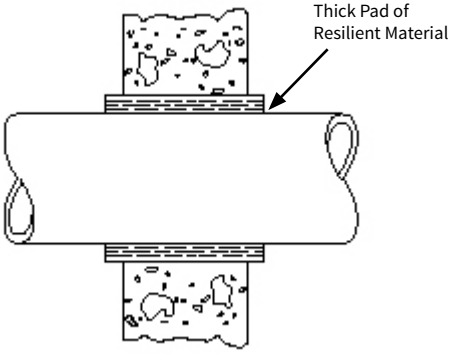
Improper Bedding

Road Crossings - When laying fiberglass pipe under road crossings, it may be necessary to pass the pipe through conduit to protect the pipe. Pad the pipe to prevent rubbing or point loads against the conduit.



Wall Penetrations

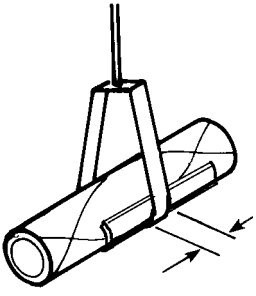
Where the pipe goes through or passes under a concrete structure, precautions must be taken to prevent bending or point loading of the pipe due to settling. A minimum 2" thick pad of resilient material should be wrapped around the pipe to provide flexibility and prevent contact with the concrete. If bolts are used in the resilient material, care should be taken that the bolts, nuts, or washers cannot come into point load contact with the pipe. Bedding depth under the pipe should be increased to a minimum of 12" or one pipe diameter, whichever is greater, for one pipe joint length away from the concrete.



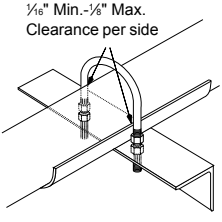
Timing - Test and cover the pipe as soon as possible to reduce the chance of damage to the pipe, floating of the pipe due to flooding, or shifting of the line due to cave-ins.

Anchors, Guides and Supports

Pipe Hangers - Pipe hangers such as those shown are often used to support pipe in buildings and pipe racks. However, the use of too many hangers in succession can result in an unstable line when control valves operate, and during pump start-up and shutdown. To avoid this condition, the designer should incorporate auxiliary guides periodically in the line to add lateral and axial stability.



Pipe Guides - are rigidly fixed to the supporting structure and allow the pipe to move in the axial direction only. Proper guide placement and spacing are important to ensure proper movement of expansion joints or loops and to prevent buckling of the line.

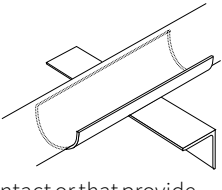


The guiding mechanism should be loose so it will allow free axial movement of the pipe. "U" bolts, double-nutted so they cannot be pulled down tight, are often utilized for guides.

Primary and secondary guides, i.e., those immediately adjacent to expansion joints, are spaced more closely than intermediate guides. Refer to Engineering & Piping Design Manual, for details.

Piping entering expansion joints or expansion loops require additional guides. Refer to Engineering & Piping Design Manual for details.

Pipe Supports - spacing should be spaced at intervals as shown in the product bulletins.



NOTE: Properly spaced supports do not alleviate the need for guides as recommended in the preceding section. Supports that make only point contact or that provide narrow supporting areas should be avoided. Some means of

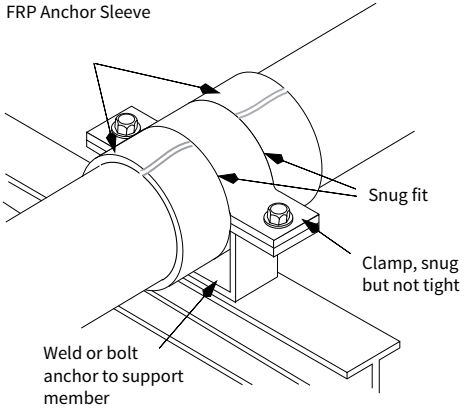
increasing the supporting area should be used; sleeves made from half of a coupling or pipe are suitable. Support pumps, valves and other heavy equipment independent of the pipe. Refer to pump and valve connection instructions on page 61.

Pipe Anchors - divide a pipeline into individual expanding sections. In most applications, major pieces of connected equipment, such as pumps and tanks, function as anchors. Additional anchors are usually located at valves, near changes in direction of the piping, at blind ends of pipe, and at major branch connections. Provisions for expansion should be designed into each of the individual pipe sections.

Do not install more than one expansion joint or expansion loop between two anchors.

Do not anchor pipe by applying external pressure as point loads, such as a "U"-bolt, directly to the bare pipe

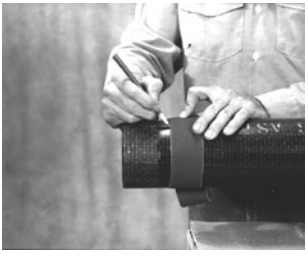
Refer to Engineering & Piping Design Guide, for a thorough discussion on supports, anchors and guides.



Cutting Fiberglass Pipe

Fiber Glass Systems' pipe should be cut using one of the methods referred to under Tools and Equipment on page 18.

1. Measure pipe, remembering to allow for spigot and fitting dimensions.
2. Scribe a cutting guide around the pipe to ensure a perpendicular cut for proper fit.
3. Hold the pipe firmly but not to the point of crushing. If chain vises or other mechanical holding devices are used, care should be taken to prevent crushing or point loading of the pipe. To prevent damage to the pipe, 180 degree sections of pipe can be used for protective covers.
4. Saw the pipe as smoothly as possible. The pipe ends should be square within 1⁄8 inch.



Cutting guide

Sawing the pipe

NOTES:

- Centricast pipe should be above 55°F when cutting. Preheat with a heat blanket if ambient temperature is below 55°F.
- Z-Core pipe should be warmed to a minimum ID temperature of 100°F prior to cutting using a heat blanket.
- Inspect the inside diameter of the pipe after cutting to be sure it has not been damaged by saw cracking or during handling.

Assembly Layout

Refer to Table 6 for "Take-Off Dimensions" for socket joint fittings or Tables 7 and 8. The method for calculation is similar to the method for any other piping system.

a. Determine the required finished length of the pipe spool sections from the drawing.

b. Subtract the take-off dimension for each fitting in the spool section.

c. Cut the pipe to the length determined as the take-off dimension (b. above).

d. As a double check, dry fit the pipe and fitting(s) to confirm the finished length is correct.

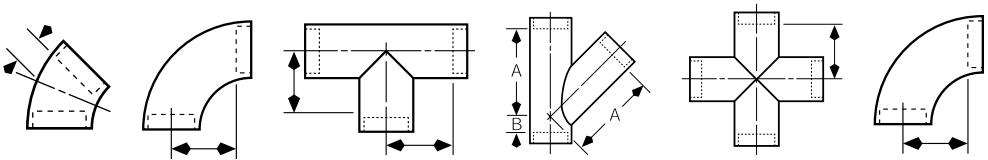
e. Mark the cut pipe lengths with the pipe spool identification number from the blueprint to avoid later confusion. Many pipe lengths can be cut at one time to allow improved efficiency in pipe fabrication.

Consult Fittings & Accessories Bulletins for complete fitting dimensions and other data.

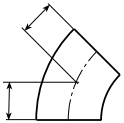
Table 6.0

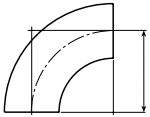
Take-off Dimensions for CL, RB & ZC Socket Fittings

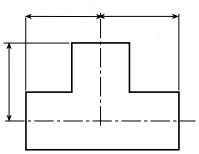
Pipe stop to fittings' center line dimensions. The dimensions are used to calculate pipe length requirements to meet pipeline center line to center line dimensions.

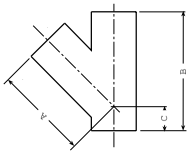


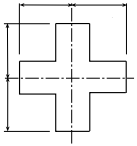
Size	Fig. 265C 45°Elbow		Fig. 255C 45°Elbow	Fig. 275C Tee		Fig. 265C		Fig. 285C Cross	Fig. 257C LR90°Elbow
	PM	HLU		PM	HLU	A	B		
	in	in	in	in	in	in	in	in	in
1	1 5/16	9/16	1 5/16	1 5/16	2 5/16	-	-	-	3 13/16
1 1/2	1	15/16	1 7/16	1 7/16	2 11/16	-	-	-	4 11/16
2	1 7/16	1 1/16	2	2	2 11/16	5 11/16	1 3/16	1 3/8	4 11/16
3	1 15/16	1 3/16	2 5/8	2 5/8	3 11/16	7 1/8	1 1/8	2 3/16	5 15/16
4	2 1/4	2 3/16	3 1/4	3 1/4	4 11/16	9 3/16	7/8	3 1/2	7 3/16
6	2 15/16	3 3/16	4 3/16	4 3/16	6 3/16	15 9/16	5 5/16	4 3/16	9
8	-	3 5/16	4 7/8	-	5 1/16	18 11/16	5 5/16	5 3/16	12
10	-	3 11/16	-	-	8 3/16	22 7/16	6 7/16	8 3/16	13 11/16
12	-	4 11/16	-	-	9 3/16	27 15/16	7 5/16	9 3/16	16 3/16
14	-	5 3/8	-	-	9 5/8	-	-	-	18











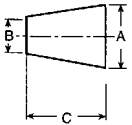
Size	45°Elbow	90°Elbow	Tee	Lateral			Cross
				A	B	C	
	in	in	in	in	in	in	in
14	8¾	21	18	30	42	12	18
16	10	24	20	32	46	14	20
18	11¼	27	21	38	54	16	22
20	12½	30	22	38	54	16	22
24	15	36	24	42	60	18	24
30	18⅝	45	30	52	72	20	30
36	22½	54	33	62	84	22	33
42	26	63	36	72	96	24	36
48	29⅞	72	42	---	---	---	---
54	33½	81	45	---	---	---	---
60	37¼	90	54	---	---	---	---
72	44¾	108	60	---	---	---	---

Table 7.0
Take-off Dimensions for 14"-72" F-Chem Plain End & Flanged Fittings

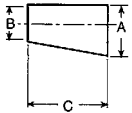
Table 8.0

Take-off Dimensions for 14"-72" F-Chem Plain End & Flanged Reducers

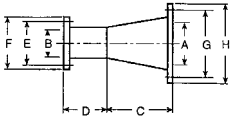
Size (inch)						
A B	C	D	E	F	G	H
14 x 10	10	10	14 ¼	16	18 ¾	21
14 x 12	5	10	17	19	18 ¾	21
16 x 12	10	10	17	19	21 ¾	23 ½
16 x 14	5	12	18 ¾	21	21 ¾	23 ½
18 x 14	10	12	18 ¾	21	22 ¾	25
18 x 16	5	12	21 ¼	23 ½	22 ¾	25
20 x 16	10	12	21 ¼	23 ½	25	27 ½
20 x 18	5	12	22 ¾	25	25	27 ½
24 x 18	15	12	22 ¾	25	29 ½	32
24 x 20	10	12	25	27 ½	29 ½	32
30 x 20	25	12	25	27 ½	36	38 ¾
30 x 24	15	12	29 ½	32	36	38 ¾
36 x 24	30	12	29 ½	32	42 ¾	46
36 x 30	15	15	38 ¾	36	42 ¾	46
42 x 30	30	15	38 ¾	36	49 ½	53
42 x 36	15	15	42 ¾	46	49 ½	53



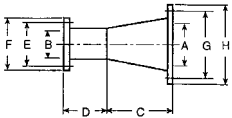
Plain End Eccentric



Plain End Eccentric



Flanged Eccentric



Flanged Concentric

Notes:

Section 3

Socket Joint Fabrication

Read This First
Cutting Fiberglass Pipe

Socket Joint Fabrication

Straight socket adhesive joints are designed for:

1. High strength
2. Easy, quick fabrications
3. Minimum of tools and procedures
4. High reliability

The adhesives provide reinforcement in the bond area and are designed to prevent void areas. There are only a few important procedures, but you must follow them correctly to achieve a good bond. (Note: Follow complete detailed instructions supplied with each adhesive kit.).

Preparation of 1"-14" CL, ZC & RB Pipe and Fittings for Bonding

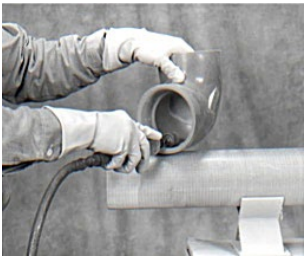
Key requirements for a good bond are:

1. **CL, ZC and RB piping:** Measure the length of the socket, add 1/2" and thoroughly sand the pipe OD with 36-60 grit material until there are no glossy areas. Re-sand the fittings sockets with 36-60 grit material to thoroughly clean the bond area. A clean, rough surface provides a bond area for good adhesion. Do not use a flapper wheel to sand pipe OD or fitting socket. Use a clean, dry rag or paper towel to remove sanding dust. **Do not use solvents. Do not use compressed air to blow sanding dust off the prepared ends as it may contain contaminates detrimental to bond strength.**

   Never sand the joint surfaces more than two (2) hours before making the joint.

"Shoe Shine" method using Emery cloth of 36-60 grit abrasive

Disk power sander for large diameter pipe. Use 36-60 grit abrasive



High speed die grinder for sanding sockets. Use drum with 36-60 grit abrasive

2. Thoroughly mix the adhesive until the color is consistent. A poor mix may result in a leaky connection. Do not mix less than a full kit or try to estimate partial quantities.

3. Thoroughly wet-out the fitting socket (see note 1 for 1" - 2" joint) by working a thin layer (approx. 1/16") of adhesive into the bonding surface of the fitting. In a similar manner, apply a generous layer (1/8" minimum) onto the pipe's OD. Also coat the cut end of the pipe to prevent chemical attack. **CAUTION:** Do not continue to use the adhesive once it has begun to set up in the can.

4. Push the fitting smoothly, straight onto the pipe. Do not turn, twist, or work the fitting as that could pull air into the joint and create a void area. Slight rotation (approx. 1/2") after insertion is acceptable for fitting alignment. Be sure there is squeeze-out all around the hub of the fitting.
5. Do not move the joint during the gelling period of the cure cycle.

Movement can cause out-of-plumb fitting alignment and a leaky joint. Heat cure is recommended for Centricast piping systems. Refer to pages 38-42 for heat curing.

WARNING: Do not use the heat blanket or collar on the CL or RB joints until the adhesive fillet is gelled and firm to the touch.

NOTE: 1", 1½", & 2" Centricast Pipe - Small diameter adhesive socket joints may be obstructed by excessive adhesive if the following instructions are not followed. Apply adhesive to the fitting socket forcing it into the sanded surface. Make sure all of the bonding surfaces are completely coated with adhesive. Remove the adhesive with the applicator leaving only a very thin film to wet all the bonding surfaces.

Any excessive adhesive left in the fittings socket will be forced into the pipe during joining and may obstruct fluid flow in the system. Wet the end of the pipe leaving a small bead of adhesive. The adhesive will prevent chemical attack of the pipe end. Apply a thin film of adhesive to the pipe forcing it into the sanded bonding surface. Next coat the bonding area of the pipe only with adhesive at least ¼" thick. Make sure there is not excessive adhesive on the end of the pipe or in the pipe bore before placing the fitting on the pipe.

Joint Cure

Heat Assist Gel: Place an industrial heat gun (1600 watt) approximately 6" away from the fitting and point at the socket. Continuously rotate slowly around the fitting until the bead is firm to the touch.

Heat Cure: We require heat curing all Centricast joints with electric heating blanket for maximum joint strength, corrosion resistance and accelerated assembly time. See pages 38-42 for Instructions for Using Heat Blankets and Collars.

Adhesive Disposal: Once the adhesive and hardener have been mixed and reacted, nothing can be extracted, and it is

classified as non-hazardous material. Dispose of in a normal manner as other solid waste. Hardener jars, when empty are not subject to EPA regulation and can be disposed of in a normal manner. These guidelines are based on federal regulations. State and local regulations and ordinances should be reviewed.

Instructions for Using Heat Blankets and Controller

CAUTION - Refer to Heat Blanket Instructions for complete operating instructions

- Use only with 120 volt power outlet. Special 240 volt heat collars are available.
- Blanket should not be used in wet conditions.
- Tears, cuts or punctures in the blanket can create a potential safety hazard.

1. Use only the proper size heat blanket for the pipe being joined. See Table 9.
2. Wrap the blanket around the joint placing the thermistor side out and the smoother side of the blanket down against the joint. Wrap around the joint until reaching the overlap. Once the blanket starts to overlap, place the tail of the blanket through the slit in the thick end of the blanket and pull it tight. The entire joint should be covered now and the small amount of blanket left should be laid out off of the thermistor. Now run the straps around the pipe, put them through their respective slots, and then pull tight. This will ensure a tight-fighting heat blanket providing you with the best cure.

NOTE: Check heat blanket temperature to be sure it is heating properly.

3. Flange joints require heating from the inside. First, lay the blanket flat with the thermistor down. Next, roll up the blanket from the tail so that once rolled up, the thermistor is facing out towards the inside of the pipe. Insert the blanket into the pipe or fitting to the depth of the adhesive joint. Leave the cord and the remaining part of the blanket exposed. The blanket may be held in position against the ID of the joint being heated by inserting a short section of smaller FRP pipe inside the rolled blanket.
4. Avoid excess flexing of the blanket. Abnormal flexing can

cause breakage and shorten the service life of the blanket. DO NOT crease the heat blanket.

5. DO NOT use cleaning solvents. Solvents penetrate the rubber and damage the heating wires.
6. DO NOT carry or move the blanket by lifting it with the cord alone. Support the weight of the blanket separately from the cord to avoid abusing the cord-to-blanket connection.

Improper sizing or use of the heat blankets can cause excess heating which can damage both the piping and heat blankets.

Table 9

Heat Blanket Models

Pipe Size	1"-3"	4"-8"	10"-14"	16"-20"
Model	B	C	D	E

Heat Blanket Cure Time

High temperature heat collars are to be used to cure Z-Core, CL and RB Centricast pipe and fittings bonded with ZC-275 and CL-200 series adhesive. The adhesive must be gelled before applying heat blankets. The use of high temperature heating blankets maximizes the strength and the corrosion resistance of the joint. The recommended cure times varies with pipe size as shown in Table 10. These cure times are valid for fabrication in environments between 70°F and 100°F. Please refer to Part II, Site Considerations, Adverse Weather Conditions for adverse environmental considerations.

Table 10

Heat Blanket Cure Times

Adhesive Grades	Pipe Size	All Joints & Fittings (hours)
ZC-275	1"-14"	1
CL-200	1"-14"	1/2

Based on controller style heat blanket

The cure time refers to the time a powered heat blanket must remain on the joint being cured. Once the cure time has been reached the blanket may be removed. The joint will be structurally sound and may be moved as required to further the piping system assembly. The joint should be allowed to cool to ambient temperature prior to hydro testing.

Instructions for Using High Temperature Heat Collars

CAUTION - Refer to Heat Collar Bulleting for complete operating instructions.

- Do not bend or fold heating collar as this may break the heating elements and cause the collar to work improperly or not at all.

For Pipe and Fittings:

1. Use the same size heating collar as the pipe size you are installing, with the exception of flanges. Do not use a heating collar that is designed for a larger size pipe. See Table 12.
2. With the un-insulated flap on the bottom (next to the fitting), carefully wrap the heating collar around the joint. Feed the strap through the square ring. Caution: The un-insulated flap is extremely hot when the collar is on. DO NOT TOUCH with bare hands.
3. Tighten the straps until the heating collar is snug against the joint.

For Flanges:

1. For 1", 11/2" and 2" flanges, an industrial heat gun may be used to cure the joint. Be sure that the end of the gun is at least six inches from the opening of the flange.
2. For 3" through 14" flange joints, use a heating collar that is one pipe size smaller than the product you are working with. Remove the straps from the heating collar.
3. Carefully turn the collar inside out with the heated area facing the I.D. of the pipe. Place the heating collar in the I.D. of the flange. A split ring of pipe may be used to hold the collar in place while the joint is curing.

For Saddles:

1. Place the heating collar over the saddle outlet. During cool weather, a wind shield is recommended to keep heat on the joint. Saddles must be heat cured for two hours.

Allow the joint to return to ambient temperature before applying stress to the joint.

NOTE: High Temperature electric heating collars are designed to fit around fittings, and will overlap on pipe joints and couplings. Exceeding the recommended cure time on pipe joints where the heating collar overlaps may shorten the life of the heating collar and/or damage the pipe.

The use of insulation may be necessary below 40°F to prevent heat loss.

High Temperature Heat Collars Cure Times

High temperature heat collars are to be used to cure Z-Core and RB series Centricast pipe and fittings bonded with ZC 275 series epoxy adhesive. The adhesive must be gelled before applying heat collars. The use of high temperature heating collars maximizes the strength and the corrosion resistance of the joint. The recommended cure times varies with pipe size as shown in Table 11. These cure times are valid for fabrication in environments between 70°F and 100°F. Please refer to Part II, Site Considerations, Adverse Weather Conditions for adverse environmental considerations.

Table 11

High Temperature Heat Collar Cure Times

Pipe Size	All Joints & Fittings (hours)
1"-6"	1/2
8"-14"	1

The cure time refers to the time a powered heat collar must remain on the joint being cured. Once the cure time has been reached the collar may be removed. The joint will be structurally sound and may be moved as required to further the piping system assembly. The joint should be allowed to cool to ambient temperature prior to hydro testing.

Table 12

High Temperature Heat Collar Cure Models (for use with ZC and RB pipe only)

Pipe Size	Model Number	
	110 VAC	240 VAC
1"	005990-500-0	005990-500-1
1 ½"	005990-501-0	005990-501-1
2"	005990-502-0	005990-502-1
3"	005990-503-0	005990-503-1
4"	005990-504-0	005990-504-1
6"	005990-505-0	005990-505-1
8"	005990-506-0	005990-506-1
10"	005990-507-0	005990-507-1
12"	005990-508-0	005990-508-1

Section 4

Butt & Wrap Joint Fabrication

Butt & Wrap Joint Fabrication

Surface/End Preparation

NOTE: It is essential to good fabrication that pipe and fitting surfaces be sanded, clean, dry, and free of oil, grease, and solvent contamination.

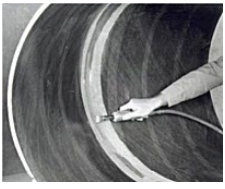
1. Prepare both ends of the pipe, or pipe and fitting to be joined, by sanding the bonding surfaces with 36 to 60 grit abrasive. The sanded area should extend at least 1/2" beyond the widest layer of glass.

Example: 14" Pipe Size.

The widest layer of fiberglass is 8", therefore, sand the pipe ends to a distance of 4 1/2" from each cut end.

2. Never sand the joint surfaces more than two (2) hours before making the joint.
3. Wipe the sanded area with a clean, dry, lint-free cloth, and avoid touching the surfaces with bare hands or dirty gloves. Do not use solvents.

Interior Surface Preparation



For 24" and larger piping, where accessible, use a die grinder to sand the interior surface of the pipe 3" from the joint ends. This will provide a proper bonding surface for applying the veil, mat, and resin to the pipe's interior surface.

Sealing and Securing The Pipe Ends

Coat the sawed ends of the pipe and/or fittings with catalyzed resin or Weldfast CL-200 Adhesive before joining the ends. Mix Weldfast CL-200 per the instructions in the Weldfast Kit. Sealing the pipe ends protects the fiberglass reinforcement from chemical attack.

Hot Patches

Hot patches are used to prevent joint movement during the Field Weld procedure. Hot patches are small pieces of Fabmat, approximately 4" x 6", which are included in the Field Weld Kit. Two (2) patches should be used on pipe up to 20" diameter, and three (3) patches on all pipe larger than 20". Only a small amount of resin is required to apply hot patches. Mix one pint of resin with 12 ml. of catalyst. Saturate the patches with the catalyzed resin, and apply to the piping with the mat side to the pipe.

The hot patches need to harden before applying joint filler. Heat may be applied to accelerate hardening of the catalyzed resin.

Joint Filler

Weldfast CL-200 adhesive is used to fill gaps and voids caused by uneven saw cuts and differences in pipe outside diameters.

Mix according to the instructions provided in the Weldfast Kit. Apply enough catalyzed adhesive to fill all of the gaps and provide smooth transitions where the pipes join. Let the adhesive harden and re-sand the joining surfaces before applying the Field Weld resin and glass. Heat may be applied to accelerate hardening of the adhesive.

Mixing the Standard Lay-Up Resin

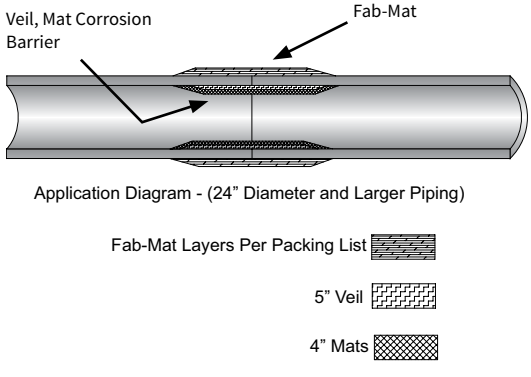
1. Measure the recommended amount of catalyst using the graduated measuring beaker. See the Cure Times Chart on page 49.

2. Pour the measured catalyst into 1 quart of vinyl ester resin and stir until completely blended. When the resin is properly blended, the color will be consistent and will start to foam.

The standard mix of resin is 16 ml. of catalyst for each quart of vinyl ester resin. After the first quart of resin is mixed and a layer of fiberglass has been applied, it may be evident that the ratio of catalyst should be changed to allow more or less working time. If more working time is required, use as little as 13 ml. of catalyst to each quart of resin. This will normally double the pot life and the curing time. If a quicker cure is required, use up to 22 ml. of catalyst for each quart of resin. This will shorten the pot life and cure time.

IMPORTANT NOTE! Never use less than 13 ml. or more than 22 ml. of catalyst for each quart of resin. "Smoking" or "crazing" of a joint indicates an over-catalyzed resin. Joints made with over catalyzed resin will be structurally weak, provide poor chemical resistance, and should not be used.

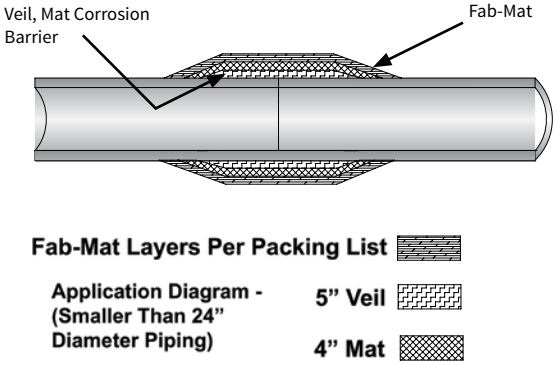
Inside Corrosion Barrier (24" Diameter and Larger Piping)



Inside corrosion barriers improve the structural and chemical integrity of the pipe. When possible, always make inside corrosion barriers when joining large diameter pipe, using the following procedures:

1. Wet the sanded surface of the piping interior with a light coat of catalyzed resin.

2. Arranging the materials on a flat surface or table top, pre-wet two layers of 4" wide, fiberglass mat, and one layer of veil. Be sure the veil is the top layer.
3. Apply the pre-wetted layers, centering the glass over the joint. Be sure the veil is toward the center of the pipe.



Exterior Corrosion Barrier (Smaller Than 24" Diameter Piping)

If an inside corrosion barrier cannot be made, a corrosion barrier must be made on the exterior joining surfaces of the piping, using the following procedures:

1. Wet the sanded surface of the piping exterior with a light coat of catalyzed resin.
2. Arranging the materials on a flat surface or table top, pre-wet two layers of 4" wide fiberglass mat, and one layer of veil. Be sure the veil is the top layer.
3. Apply the pre-wetted layers, centering the glass over the joint. Be sure the veil is against the pipe.

Applying the Fiberglass Reinforcement

Apply all the fiberglass layers, as supplied in the Field Weld Kit, for the pressure rating and size of the pipe being joined. Start with the narrowest Fabmat at the pipe surface and proceed to the widest Fabmat. (See Application Diagram for the proper sequence and staging of fiberglass strips to be laid-up.)

Pre-wet with resin, a layer of fiberglass on a table or flat surface. Pick up the wetted layer of fiberglass and place it over the joint. Apply each layer of Fabmat with the mat side down. As each layer is applied, roll out the wrinkles or trapped air with the 3" paint roller.

Mixing and Applying The Finish Coat

After all the layers of fiberglass have been applied to the joint, and the joint has gelled or semi-hardened, apply a final coat of catalyzed resin using the 3" paint roller or a brush. This finish coating is in a separate container marked "Finish Coat Resin." This resin should be catalyzed using the same procedure as for the standard lay-up resin. If less than one quart of Finish Coat Resin is required, reduce the recommended amounts of catalyst proportionately.

Application of the special Finish Coat Resin is critical to developing a chemical resistant piping surface and joint.

ADHESIVE DISPOSAL: Once the adhesive and hardener have been mixed and reacted, nothing can be extracted, and it is classified as non-hazardous material. Dispose of in a normal manner as other solid waste. Excess adhesive and hardener can be mixed, allowed to react, and disposed of as above. If extra jars of adhesive or hardener have accumulated without the other component to mix and react, contact your Regional Manager. Hardener jars, when empty are not subject to EPA regulation and can be disposed of in a normal manner. These guidelines are based on federal regulations. State and local regulations and ordinances should be reviewed.

Joint Cure

The minimum required cure time is 24 hours at 70°F. Inadequate joint strength will result if the catalyzed resin is cured at temperatures less than 60°F. Heat cure at 200°F to 275°F will accelerate cure time and increase joint strength.

Heat cure is highly recommended for piping systems carrying fluids at temperatures above 120°F. Before pressurizing the piping system, or moving the piping, cure the joint. See the Cure Times Chart below.

NOTE: See pages 62-63 for hydrostatic testing and system start-up procedure. Bonding surfaces must be dry, so be sure all solvent has evaporated before applying adhesive.

Table 13

Vinyl Ester Butt Weld Kit Cure Times

Temp. (°F)	Part A Shelf Life (months)	Part B Shelf Life (months)	Pot Life (min)	Gel Time (min)	Joint Cure Time (hours)
40-49	6	12	N/R	N/R	N/R
50-59	5	12	N/R	N/R	N/R
60-69	3-4	12	20-40	25-45	36
70-79	3-4	12	20-40	25-45	24
80-89	2-3	9	15-35	18-38	24
90-100	1-2	4	8-15	10-18	16
200-250	-	-	-	-	2-4

Section 5

Installation Considerations

Testing
System Start-Up
Water Hammer
Fiberglass Flanges
Connecting to Other Systems
Painting Pipe

Flange & Fitting Alignment

As with any piping system, flanges must be set for proper alignment of bolt patterns and fittings must be set to be plumb. Arrangement of the work pieces before adhesive bonding is the key to easy fabrication.

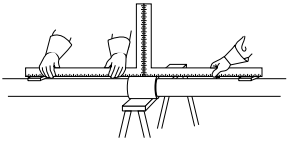
1. Level the pipe on the work table or pipe stands.
2. Dry-fit components to check dimensions.
3. Layout levels, plumb bobs that will be needed.
4. Follow the recommended procedures in sanding, adhesive mixing and bonding.
5. Immediately after inserting the pipe into the fitting socket, adjust the fabrication for correct alignment. For example, a flange may need to be rotated slightly for correct bolt hole alignment. About ½" of rotation on a flange should be the limit of movement. The same applies for plumbing an elbow. Excessive movement can create entrapped air and a leak path when the system is pressurized.
6. Hold the fabrication rigid - no movement - until the adhesive gels. This may require tape, pipe supports, or shims.
7. Check the fabrication during the gel stage to be sure it has not been bumped or moved.
8. Thoroughly heat-cure the joint before applying pressure.

NOTE: If a fabrication has been moved so that the bond is questionable, pull it apart and re-fabricate. If the adhesive is fresh and soft, simply re-apply adhesive to the pipe and fitting. If the adhesive has begun to gel, it is probably easier to let it cure, sand it off and re-do the entire joint procedure.

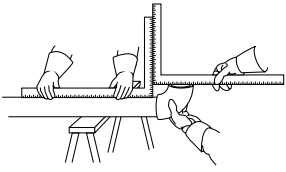
Pipe Alignment: Proper alignment is one of the most important tasks performed by the pipe fitter. If done correctly, installation will be much easier and the piping system will be properly fabricated. If alignment is poor, however, fit-up will be difficult and the piping system may not function properly.

Methods of alignment vary widely throughout the trade. The procedure in this manual will enable you to obtain good alignment.

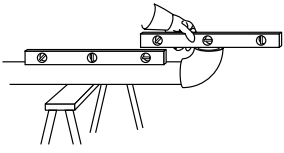
Pipe-To-Pipe: Bond pipe lengths together with coupling. Take a long straight edge and place on top of pipes. Measure several locations to make sure both pipes are parallel with the straight edge. Adjust pipes as needed. Move straight edge to the side of the pipes and repeat measurements. Correct alignment by moving pipes as needed. Hold pipes rigid until adhesive is gelled.



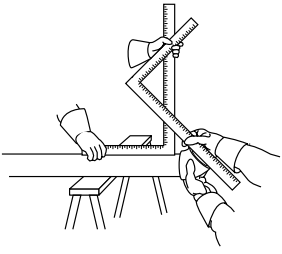
90 Degree Elbow-To-Pipe: Install fitting on pipe to close visual alignment. Center square on top of pipe. Center second square on elbow's alternate face. Move elbow until squares are aligned. Hold rigid until adhesive is gelled.



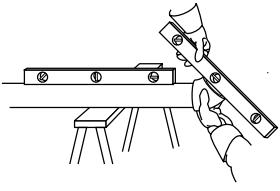
Alternate Method: Use same procedure to bond fitting to pipe. Level pipe in stand. Place spirit level on elbow's alternate face and adjust if needed. Move spirit level to opposite direction and rotate to level. Hold rigid until adhesive is gelled.



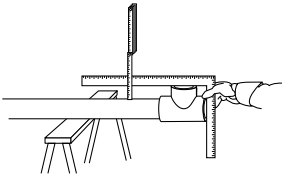
45 Degree Elbow-To-Pipe: Install fitting on pipe to close visual alignment. Follow procedure described above; squares will cross. To obtain correct 45 degree angle, align the same numbers on the inside scale of the tilted square and adjust fitting to conform. Hold rigid until adhesive is gelled.



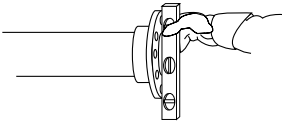
Alternate Method: Use same procedure to bond pipe and fitting. Center spirit level on pipe. Next, center 45 degree spirit level on face of elbow and move elbow until 45 degree bubble is centered. Hold rigid until adhesive is gelled.



Tee-To-Pipe: Place square on tee as illustrated. Center rule on top of pipe. Blade of square should be parallel with pipe. Check by measuring with rule at several points along the pipe. Move square 90 degrees to side of pipe and recheck plumb by measuring with rule along side of pipe. Hold rigid until adhesive is gelled.

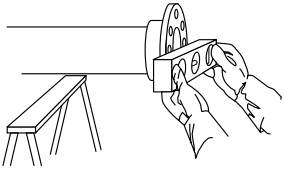


Flange-To-Pipe:



Step 1 Level pipe in stands or vise.

Step 2 Install flange on pipe to close visual alignment. Align top two holes of flange with spirit level. Move flange until bubble is centered.

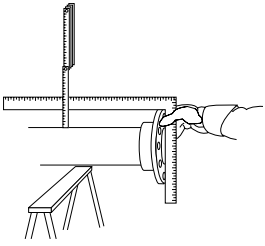


Step 3 Use spirit level to adjust flange face to be vertical or plumb.

Step 4 Rotate assembly 90 degrees and repeat Step 3.

Step 5 Hold rigid until adhesive is gelled.

Alternate Method:



Step 1 Install flange on pipe to close visual alignment. Align top two holes of flange with spirit level. Move flange until bubble is centered.

Step 2 Center square on face of flange. Center rule on top of pipe. Move flange until square and pipe are parallel.

Step 3 Center square on face of flange. Center rule on side of pipe and align as in Step 2.

Step 4 Hold rigid until adhesive is gelled.

Flanges

Flange Gaskets & O-Ring Requirements

For RB, CL, & ZC, full-face gasketing materials, 3⁄16" thick, with a Shore A hardness of 60 to 70 durometer, are recommended. **F-Chem** flanges require full-face gasketing material 1⁄4" thick or O-ring seals depending on pressure ratings. Refer to Table 14.

Flat gaskets made from Teflon® and PVC usually have high durometer ratings and are not acceptable.

Table 14

Gasket & O-Ring Requirements for F-Chem Stub Flanges & Flanged Fittings

Pipe Size	Pressure Rating	Gasket[1]		O-Ring[2]	
		I.D.	O.D.	Cross Section	I.D.
in	psig	in	in	in	in
14	50-100 125-150	14 3⁄16 -	21 -	- .275	- 15.475
16	50-100 125	16 3⁄16	23 ½	- .275	- 17.455
18	50-100 125	18 3⁄16 -	25 -	- .275	- 19.455
20	50-75 100	20 3⁄16 -	27 ½ -	- .275	- 21.629
24	50-75 100	24 3⁄16 -	32 -	- .275	- 26.129
30	50-75 100	30 3⁄16 -	38 ¾ -	- .375	- 31.975
36	50-75 100	36 3⁄16 -	46 -	- .375	- 36.180
42	50 75-100	42 3⁄16 -	53 -	- .375	- 44.620
48	50 75-100	48 1⁄16 -	59 ½ -	- .500	- 50.680
54	50-75	-	-	.500	56.770
60	50-75	-	-	.750	62.590
72	50-75	-	-	.750	75.340

[1] Use ANSI 16.1 class 125 lb drilling gasket with a hardness of 50 to 70 durometer on the Shore A scale.

[2] Use O-Ring with a hardness of 50-70 durometer on the Shore A scale.

Standard Bolting Conditions

Flanges meet OD, bolt circle diameter, number of holes and bolt hole diameter dimensions for ANSI B16.1, 125 lb. cast iron sizes 30"-72" and ANSI B16.5, 150 lb. steel for 1"-24" diameters.

NOTES:

1. Standard Bolt Description:
   Diameter - Threads per inch x length.
2. Bolt lengths are nominal. When joining flanges to flanges of other material or manufacturers, the bolt length must be calculated.
3. Use two washers with each bolt. Use SAE standard washers under all nuts and bolt heads up to 48" size. Use USS wrought washers for 54" and larger sizes.
4. Bolt torque based on National Coarse threads.

Table 15

Bolt, Washer & Torque Requirements for CL, RB, ZC Flanges & Fabricated Flanged Fittings

Flange Size (in)	# of Bolts	Machine Bolt Size	Stud Bolt Size	Maximum Allowable Torque ft. lbs.
1	4	½ - 13 x 3	½ - 13 x 3½	10/10
1 ½	4	½ - 13 x 3½	½ - 13 x 4	20/15
2	4	⅝ - 11 x 3½	⅝ - 11 x 4½	50/35
3	4	⅝ -11 x 3½	⅝ - 11 x 4½	50/35
4	8	⅝ - 11 x 4½	⅝ - 11 x 5	50/35
6	8	¾ - 10 x 4½	¾ - 10 x 5½	50/35
8	8	¾ - 10 x 5½	¾ - 10 x 6½	50/35
10	12	⅞ - 9 x 8	⅞ - 9 x 9	50/35
12	12	⅞ - 9 x 8	⅞ - 9 x 9	50/35
14	12	1 - 8 x 10½	1 - 8 x 12	50/35
Integral Flanged Fittings				
1	4	½ - 13 x 3	½ - 11 x 3½	10/10
1 ½	4	½ - 13 x 3½	½ - 13 x 4	20/15
2	4	⅝ - 11 x 3½	⅝ - 11 x 4½	30/20
3	4	⅝ - 11 x 3½	⅝ - 11 x 4½	30/20
4	8	⅝ - 11 x 4½	⅝ - 11 x 5	30/20

Table 16

Bolt, Washer & Torque Requirements for Van Stone-Type Flanges

Flange Size (in)	Backing Flange Material	# of Bolts	Machine Bolt Size	Stud Bolt Size	Maximum Allowable Torque ft. lbs.
					Dry/Lubricated
2	FRP	4	5/8 - 11 x 5	5/8 - 11 x 5 1/2	50/35
3		4	5/8- 11 x 5	5/8 - 11 x 5 1/2	50/35
4		8	5/8 - 11 x 5	5/8 - 11 x 6	50/35
6		8	3/4 - 10 x 5 1/2	3/4 - 10 x 6 1/2	50/35
2	Steel	4	5/8 - 11 x 4	5/8 - 11 x 4 1/2	50/35
3		4	5/8 -11 x 4	5/8 - 11 x 4 1/2	50/35
4		8	5/8 -11 x 4	5/8 - 11 x 4 1/2	50/35
6		8	3/4 -10 x 4	3/4 - 10 x 5	50/35

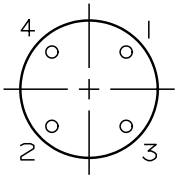
Table 17

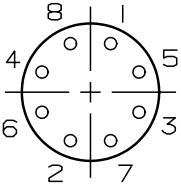
Bolt, Washer & Torque Requirements for F-CHEM Flanges & Flanged Fittings

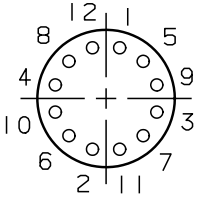
Flange Size (in)	Pressure Rating (psi)	# of Bolts	Machine Bolt[1] Size	Stud Bolt [1] Size	Bolt Torque (ft lb)	
in	psi				nom	max
14	50	12	1 - 8 x 4½	1 - 8 x 6	75	100
	75	12	1 - 8 x 5	1 - 8 x 6	85	110
	100	12	1 - 8 x 5	1 - 8 x 7	90	120
	125	12	1 - 8 x 5½	1 - 8 x 7	50	100
	150	12	1 - 8 x 6	1 - 8 x 7	50	100
16	50	16	1 - 8 x 4½	1 - 8 x 6	75	100
	75	16	1 - 8 x 5	1 - 8 x 6	85	110
	100	16	1 - 8 x 5½	1 - 8 x 7	90	120
	125	16	1 - 8 x 6	1 - 8 x 7	50	100
18	50	16	1⅛ - 7 x 5	1⅛ - 7 x 6	75	100
	75	16	1⅛ - 7 x 5½	1⅛ - 7 x 7	85	110
	100	16	1⅛ - 7 x 6	1⅛ - 7 x 7	90	120
	125	16	1⅛ - 7 x 6½	1⅛ - 7 x 8	50	100
20	50	20	1⅛ - 7 x 5	1⅛ - 7 x 7	90	120
	75	20	1⅛ - 7 x 5½	1⅛ - 7 x 7	105	140
	100	20	1⅛ - 7 x 6	1⅛-7x8	75	125
24	50	20	1¼ - 7 x 5½	1¼ - 7 x 7	90	120
	75	20	1¼ - 7 x 6	1¼ - 7 x 8	105	140
	100	20	1¼ - 7 x 6½	1¼ - 7 x 8	75	125
30	50	28	1¼ - 7 x 6	1¼ - 7 x 8	105	140
	75	28	1¼ - 7 x 6½	1¼ - 7 x 8	120	160
	100	28	1¼ - 7 x 7	1¼ - 7 x 9	75	125
36	50	32	1½ - 6 x 6½	1½ - 6 x 9	105	140
	75	32	1½ - 6 x 7½	1½ - 6 x 9	120	160
	100	32	1½ - 6 x 8	1½ - 6 x 10	100	150
42	50	36	1½ - 6 x 7	1½ - 6 x 9	120	160
	75	36	1½ - 6 x 8	1½ - 6 x 10	100	150
	100	36	1½ - 6 x 8½	1½ - 6 x 10	100	150
48	50	44	1½ - 6 x 7½	1½ - 6 x 9	120	160
	75	44	1½ - 6 x 8	1½ - 6 x 10	100	150
	100	44	1½ - 6 x 9	1½ - 6 x 11	100	150
54	50	44	1¾ - 5 x 8	1¾ - 5 x 10	100	175
	75	44	1¾ - 5 x 9	1¾ - 5 x 11	100	175
60	50	52	1¾ - 5 x 8½	1¾ - 5 x 11	100	175
	75	52	1¾ - 5 x 9½	1¾ - 5 x 12	100	175
72	50	60	1¾ - 5 x 9½	1¾ - 5 x 11	125	200
	75	60	1¾ - 5 x 11	1¾ - 5 x 13	125	200

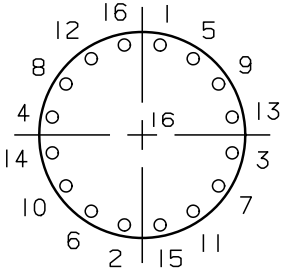
[1] Special bolt lengths are required for blind flanges.

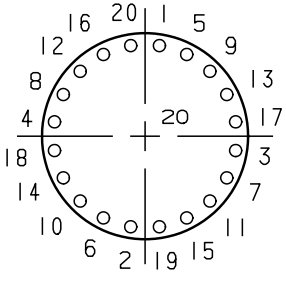
Recommended Bolt Torquing Sequence for Flanges

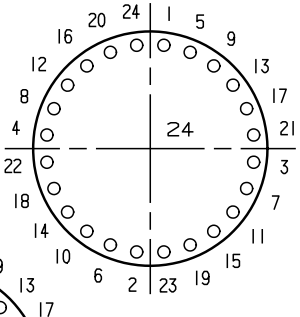


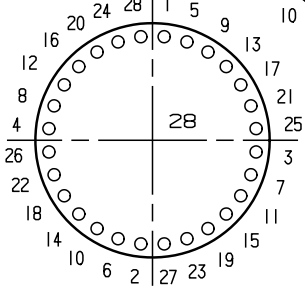


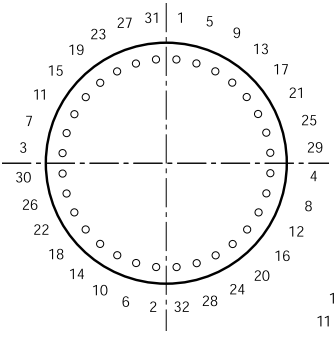








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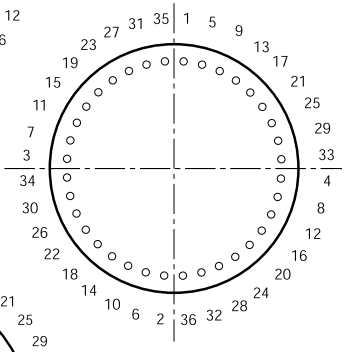
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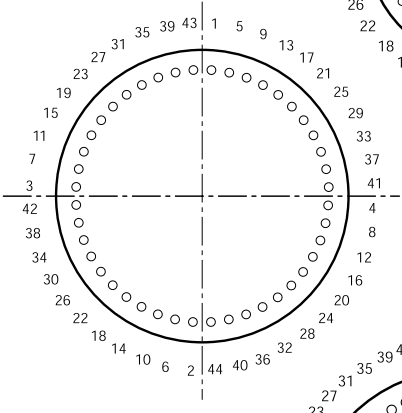
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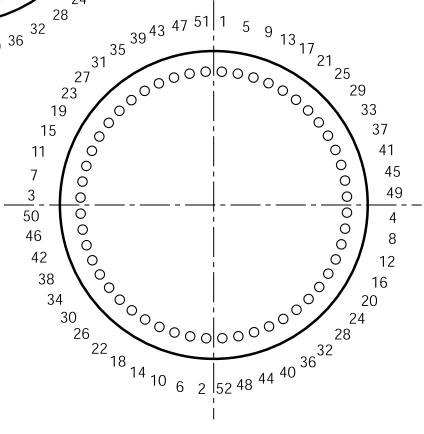
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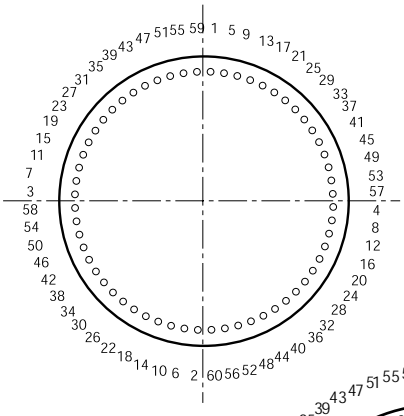
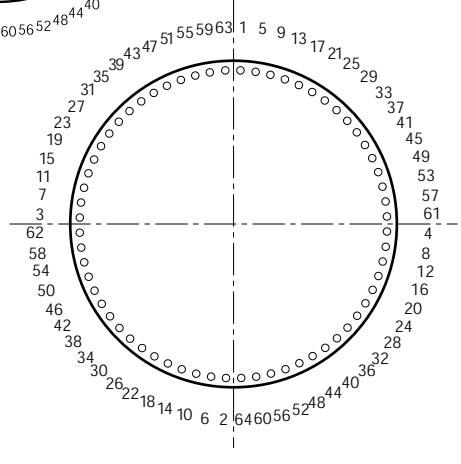
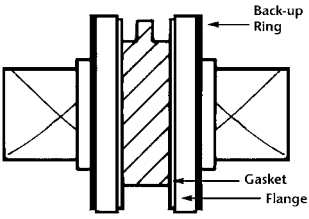




Special Flange Bolting Conditions

Often it is necessary to mate flanges with components that do not have a full flat face surface such as raised face flanges, butterfly or check valves with partial liner facings, and Van Stone flange hubs. The addition of a hard spacer ring or steel back-up ring placed between the raised face and the outer edge of the flange to form a full flat face on the mating flange is recommended. The purpose of the spacer is to fill the gap outside the raised face to prevent bolt loads from bending and breaking the flange. Spacer rings are not required if a Van Stone-type flange is used when connecting to raised face flanges, valves or pumps.



Compression Molded Flanges

Figure 8.4

Back-up Ring Thickness	
Pipe Size	Ring Thickness
1" - 12"	9/16"

Connecting to Other Piping Systems

It is often necessary to connect our piping to another piping system or make a connection which will not be possible using flanges. Threaded connections are offered - primarily for instruments, thermo wells, etc. Select the appropriate fitting from the Fittings & Accessories Bulletins. Victaulic-type grooved adapters are also available for use with Series 77 coupling in certain sizes.

Threaded Joints

1. Before making any threaded joints, be sure all bonded joints are fully cured.
2. Apply thread lubrication to both male and female threads. A material which remains soft for the life of the joint is preferred. Be sure the thread lube is suitable for the fluid service.
3. Tighten the joint to seal. Do not over-torque. FRP threads should be handled carefully - as if they are brass.

NOTES:

1. The use of adhesive to bond a steel or metal pipe into a flange is not recommended.
2. If mating our piping system to steel or other FRP system, the preferred method is with flanges. Terminate the old system with the other FRP flange and bolt our flange on the new system.
3. Be sure to check the anchors, guides, and supports of an existing system to avoid transfer of any stresses or thermal expansion loads into the system.

4. Do not try to thread pipe or fittings. This is very difficult and risky. Purchase the required factory part.

Tips: If no thread lube is available, the use of Weldfast Part "A" will usually be acceptable. Two wraps of Teflon® tape may also be used in lieu of thread lubricant.

Pump & Equipment Connection

Pipe connections to pumps or other equipment that involve vibration, shock loads or other mechanical movements should include flexible connectors. These flexible connectors allow for the absorption of vibration and eliminate the placing of undue strain on the pipe and fittings. A bellows-type expansion joint is recommended, although rubber hose has also been used with success.

Hydrostatic Testing and System Startup

Hydrostatic Testing: When possible, piping systems should be hydrostatically tested prior to being put into service. Care should be taken when testing, as in actual installation, to avoid water hammer.

All anchors, guides and supports must be in place prior to testing the line. To hydrostatically test the line, observe the following:

Water is usually introduced into the system through a one-inch diameter or smaller pipe. Provision for bleeding air from the system should be made. Water should be introduced at the lowest point in the system and the air bled off through a partially open valve or loose flange at all high points in the system. Slowly close the valve, and bring the system gradually up to the desired pressure.

Test pressure should not be more than 1-1/2 times the working pressure of the piping system, and never exceed 1-1/2 times the rated operating pressure of the lowest rated component in the system. When testing is completed open all of the high point air bleeds before draining the piping. This will prevent vacuum collapse of the pipe.

For systems with severe chemical or temperature applications, a cyclic test may replace the static test. Contact us for recommendations.

WARNING: Air Testing: Hydrostatic test should be used instead of air or compressed gas if possible. When air or compressed gas is used for testing, tremendous amounts of energy can be stored in the system. If a failure occurs, the energy may be released catastrophically, which can result in property damage and personal injury. In cases where system contamination or fluid weight prevents the use of hydrostatic test, air test may be used with extreme caution. To reduce the risk of air testing, use the table below to determine maximum pressure. When pressurizing the system with air or compressed gas, the area surrounding the piping must be cleared of personnel to prevent injury. Hold air pressure for one hour, then reduce the pressure to one half the original. Personnel can then enter the area to perform soap test of all joints. Again, extreme caution must be exercised during air testing to prevent property damage or personnel injury. If air or compressed gas testing is used, we will not be responsible for any resulting injury to personnel or damage to property, including the piping system. Air or compressed gas testing is done entirely at the discretion and risk of management at the job site.

For larger diameters, contact Fiber Glass Systems.

Pipe Diameter	1"	1 ½"	2"	3"	4"	6"	8"	10"	12"	14"
psig	25	25	25	25	25	25	14	9	6	5

System Start-Up

On any pressurized piping system, the initial start-up should be gradual to prevent excessive loads and pressure surges which may damage or weaken the piping.

One method is to slowly fill the system while bleeding off all air before starting any pumps or opening valves into pressurized piping. An alternate method is to start the centrifugal pump against a closed, adjacent valve; then slowly open the valve to gradually build up system pressure. The air should be bled off while the line is filling as in the first method.

For positive displacement pumps, consult Engineering for recommendations.

Water Hammer - Avoiding Problems

Water hammer is a term generally used to describe situations where a pressure surge in the piping system causes violent movement of the system. Usually this pressure surge is caused by a sudden valve closing, electrical outage, pump failure, or some other out-of-the ordinary situation. The pressure surge is usually brief, but damage can be severe. In FRP piping, water hammer usually results in broken fittings due to pipe system movement caused by pressure. Insufficient system anchors, guides and supports allow excessive movement of the piping and creates fitting breaks.

If you suspect water hammer, consult with the project engineer as soon as possible to eliminate the problem. This may require installing slow operating valves, a pump bypass or surge protectors in the system.

More anchors, guides or supports may need to be added. If you can easily move the piping by pushing on it, changes in the pipe support arrangement to restrict movement probably need to be made.

Air in a system can also cause water hammer. Bleed air out of the piping prior to full pressure operation. Any pipe system which moves suddenly, creates a lot of noise, or generally seems unstable is a candidate for problems due to water hammer.

Section 6

System Repair & Modification

Replacing Damaged Pipe
Replacing Damaged Fittings
Overwrap
Temporary Fixes
Tapping into a Line

System Repair & Modification

Should a leak occur during pressure testing or start up of the piping system, the normal procedure to repair is to cut out a fitting or a damaged section of pipe and replace it with new material.

Determine the fluid that has been in the piping system before beginning repairs to avoid contact with chemicals.

Systems often require modification, added instrumentation, or new branches. Components are available to easily accomplish this.

Always use the same pipe grade, fittings, and adhesive on new parts as is in the existing system. Do not mix pipe grades. If you have questions about the chemical service, pipe grade selection, existing system operating conditions, or other matter, call your local Distributor or Regional Manager.

NOTES:

1. Most leaks in a piping system are due to poor fabrication or improper installation (i.e., not properly anchored, guided or supported).
2. When making repairs, be sure all surfaces to be bonded are dry, clean and thoroughly sanded. Good adhesive connections cannot be made on wet or contaminated surfaces.

Replacing Damaged Pipe

Pipe leaks through the pipe wall are usually the result of physical damage to the pipe from impact, vacuum, excessive bending, or other abusive conditions. The damaged section should always be replaced by using the following procedures:

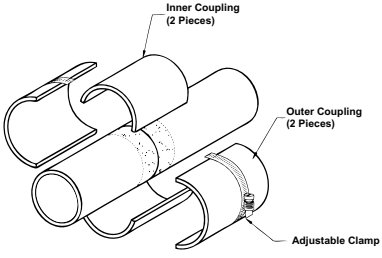
Flanged Systems: If possible, replace the entire flanged length. Otherwise, cut out the damaged section and bond new flanges to the remaining pipe ends according to recommended procedures. Next, fabricate a new flange-by-flange spool to the length required. Bolt in the new pipe section.

Flanged fittings should be removed from the system when damaged and replaced with a new fitting.

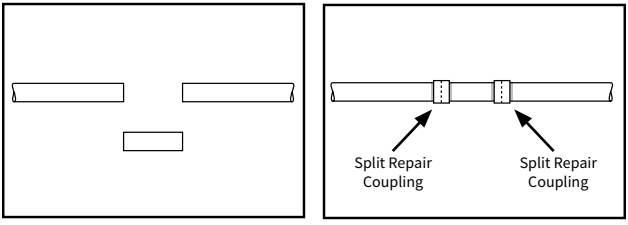
Attempt to find the cause of the damage and take corrective action. Solve the problem; don't just replace a part.

Socket/Bonded Systems: Cut out the section of pipe which leaks, making sure cuts are square. Dry the pipe ends. Cut a new length of pipe to the same length as that which was cut out. Use split repair couplings to adhesive bond the new pipe into place.

1. Before fabricating connection, all seepage or fluid at the joint area must be eliminated.
2. Sand the outer surface of the pipe thoroughly for a distance of at least 1" on either side of the anticipated contact area of the coupling, using 36 to 60 grit abrasive. Sand the inner and outer surface and mating edges of the inner two-piece coupling and sand the inner surface and mating edges of the outer two-piece coupling.
3. Brush away all the dust from the sanded areas taking care not to contaminate the sanded surfaces. Do not use a solvent wipe.
4. Slide the hose clamp over one of the pipe ends and out of the way of the joint area.
5. Mix the adhesive in accordance with the instructions provided with the adhesive kit.
6. Coat the inner and outer surfaces and mating edges of the inner coupling with a thin layer of adhesive and set aside.
7. Coat the inner surface and mating edges of the outer coupling with a thin layer of adhesive and set aside.
8. Coat the cut edges of the pipe with a thin layer of adhesive.
9. Coat the sanded outer surfaces of the mating pipe sections with a thin layer of adhesive.
10. Place the two-piece inner coupling on the pipe joint, centered over the butted pipe ends.
11. Place the two-piece outer coupling over the inner coupling with the seam rotated 90 degrees away from the seam of the inner coupling.



12. Place the hose clamp over the center of the outer coupling and tighten.
13. Remove the excessive adhesive.
14. Heat cure the adhesive in accordance with the instructions found in the adhesive kit.



Alternate Method: Use Flanges to install a new section of pipe. Cut out the damaged pipe length. Bond flanges to the remaining pipe ends using proper procedures. Fabricate a flange-by-flange spool to the required length and bolt into place.

Replacing Damaged Fittings

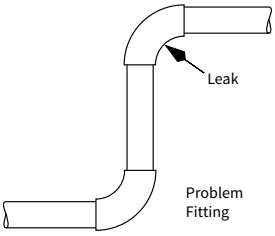
In socket adhesive systems which develop a leak in either a fitting or the socket joint area of a fitting, it will usually be necessary to cut out the leaking part and replace it.

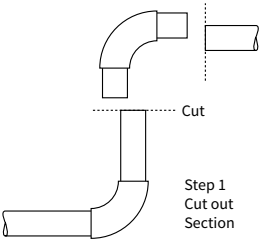
When possible, anchors, guides and supports should be loosened and some movement allowed during fabrication. Use couplings to install new pipe stubs and the new required fitting. Where the system is very rigid, it may be necessary to use flanges to allow bolting in of the replacement part. Also, if fittings are close-coupled, a series of fittings may have to be removed and replaced. Certainly, this is not desired, and an alternate overwrap method might be considered; see page 70.

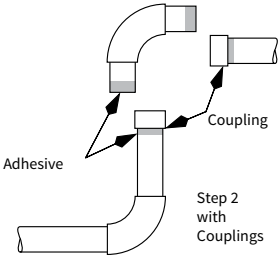
Procedures to be followed are:

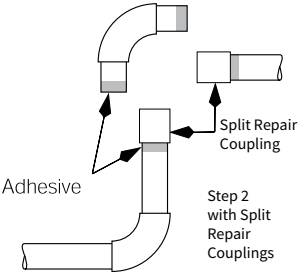
1. Determine the best location to cut the pipe section which contains the leak. Leave enough pipe length to make socket joints per the recommended procedures.
2. Dry the system.
3. If you can move the pipe ends, use couplings to bond the new part into place. Otherwise, use split repair couplings, similar to the procedures shown.

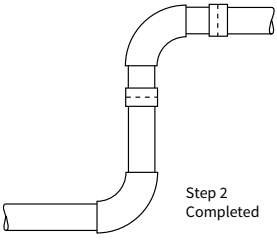
Alternate Method: If the piping arrangement does not allow the use of couplings, bond flanges to the pipe ends and bolt the replacement fitting or section into place.

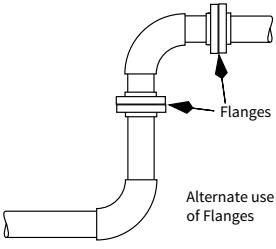










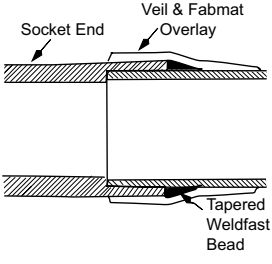


Overwrap

A leaking fitting, pipe or joint can be over wrapped with a resin and glass lay-up. This requires resin, catalyst, fiberglass reinforcement, tools, and a clean, dry work area. Many times an overwrap is the preferred method, particularly when fittings are in a close, complex manifold or assembly. Custom overwrap kits are available for each pipe size and pressure classification. Contact Fiber Glass Systems.

Application Procedure: Before making the over-wrap, read these instructions carefully.

1. Sand the surface area thoroughly for an equal distance on each side of the leak. The sanded surface should extent at least 1⁄2" beyond the widest layer of glass supplied with the kit. Remove all surface glazes, paint, oil, grease, scale, moisture, or other foreign material to ensure proper bonding of the resin material to the surface.
2. Use the applicator brush to remove all dust from the sanded area.
3. If repairing a socket joint, use the Weldfast adhesive supplied in the kit to form a tapered bead as shown in this sketch. The bead will provide a smooth transition from fitting to pipe.



4. Lay out the precut fabmat and surfacing veil on a flat, clean, dry surface (i.e., cardboard, plywood, etc.).
5. Add contents of Part "B" tube(s) to container of Part "A" (resin). Using one of the wooden stirrers, mix the contents thoroughly for at least one minute.
6. Use the applicator brush to apply a liberal, even coating of the resin mixture to the entire sanded surface.
7. Using the 3" roller, thoroughly saturate the fabmat laid out on your working surface. Apply wet-out fabmat to the joint to be overlaid placing the mat side down. Using the 3" roller, continue to roll out the material until all entrapped air has been rolled out and the fabmat is contoured smoothly to the surface.

8. For joint sizes 4" and larger, repeat step #7.
9. Place surfacing veil over the fabmat and, again using the 3" roller, apply a liberal amount of resin and work out all air as in step #7.

NOTE: Be sure that the pipe surface is thoroughly wet out with catalyzed resin.

Some guidelines on the overwrap are:

1. The overwrap should be equally spaced on each side of the point of the leak.
2. The overwrap should be around the entire circumference of the pipe or fitting.
3. The pressure rating and pipe diameter will determine the overwrap thickness. Consult Fiber Glass Systems' Technical Services to determine specific information about design of the overwrap.
4. The resin system of the overwrap should be compatible with the resin system of the existing pipe or fittings.
5. Cure the overwrap completely before pressure testing.

Temporary Fixes

Pipe Leaks: The use of a conventional metal pipe clamp is a good method for containing a small leak.

Socket Leaks: Materials are available in the marketplace for making "ace bandage" types of over wraps.

Fitting Leaks: A pinhole type leak can sometimes be stopped by applying a thickness of adhesive over a dry, sanded area.

CAUTION: If hazardous materials or high pressures are present, replace the damaged pipe or fitting at once. Do not try a temporary repair. Make a permanent repair as soon as possible.

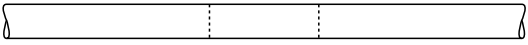
Tapping into a Line

The two most common methods for adding a branch or tapping into an existing line are the use of a tee or saddle. Saddles are often rated for lower pressure than the pipe; check the rating of the system versus the saddle. Consult Fittings & Accessories Bulletins.

Generally, the use of flanges to install a new tee is preferred.

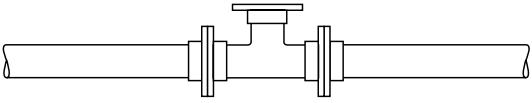
Installing a Flanged Tee:

1. Cut the pipe, leaving enough pipe to bond flanges onto the existing pipe ends.



2. Using recommended procedures, and with the system dry, bond flanges to the existing pipe ends. Be sure your measurements are exact for the new fitting to fit correctly. Cure the adhesive.

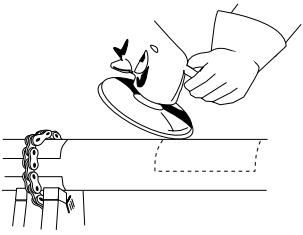
3. Install the new tee.



The procedure for installing an adhesive socket tee will be the same as for replacing a damaged socket fitting (see page 68).

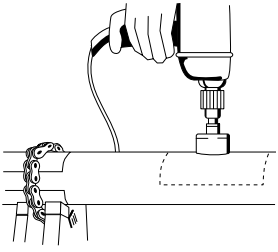
Saddles: Bonding a Saddle onto pipe is similar to making a regular adhesive socket joint. The preferred method is:

1. Lay out the required dimensions. Mark the area to be sanded by positioning the saddle on the pipe and marking the pipe.

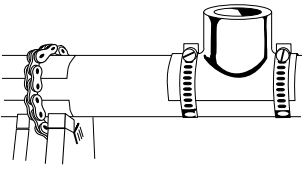


2. Sand the entire area where the saddle will bond to the pipe. A power sander or die grinder will save time. Refer to page 35 procedures concerning pipe and fitting preparation. Also, sand the bonding surface of the saddle.

3. Locate the center of the branch hole.
    a. Saddle with a cement socket outlet (1"-14"). Cut a hole the same size as the saddle outlet using a hole saw with pilot drill. Do not force the cutting tool as this will make a rough hole. Follow the same instructions as "Cutting Pipe" on page 28 when cutting the hole



    b. Saddles with an IP thread outlet (1⁄4"-1"). Prepare the surface as above. Install the saddle prior to drilling the hole. After saddle connection has cured, place a thin metal sleeve in the outlet to protect the threads, drill out the opening and coat the cut edges with adhesive. This eliminates clogging the smaller outlets with the adhesive when the saddle is pressed into position.



4. Generous amounts of adhesive must be applied to the pipe and the underside of the saddle; coat the cut edges of the hole in the pipe. Press the saddle over the hole and press into place. Use two hose clamps to tightly band the saddle onto the pipe.
5. Tighten the clamps so that the adhesive is squeezed out around the saddle. Dress the edges and clean the squeezed adhesive out of the branch as best as you can.
6. Cure the fabrication per the adhesive recommendations. The clamps can either be removed or remain on after the cure is completed.
7. Pipe or fittings in the branch run can now be fabricated.

Section 7

Helpful Information

Conversions

Conversions
Useful Formulas
Decimal Equivalents of Fractions
Definition of Terms
How to Read Flanged or Reducing Fittings
How to Figure a 45° Offset

Centigrade	Fahrenheit	Centigrade	Fahrenheit
-200	-328.0	24	75.2
-100	-148.0	25	77.0
-90	-130.0	26	78.8
-80	-112.0	27	80.6
-70	-94.0	28	82.4
-60	-76.0	29	84.2
-50	-58.0	30	86.0
-40	-40.0	31	78.8
-30	-22.0	32	89.6
-20	-4.0	33	81.4
-10	14.0	34	93.2
0	32.0	35	95.0
1	33.8	36	96.8
2	35.6	37	98.6
3	37.4	38	100.4
4	39.2	39	102.2
5	41.0	40	104.0
6	42.8	41	105.8
7	44.6	42	107.6
8	46.4	43	109.4
9	48.2	44	111.2
10	50.0	45	113.0
11	51.8	46	114.8
12	53.6	47	116.6
13	55.4	48	118.4
14	57.2	49	120.2
15	59.0	50	122.0
16	60.8	51	123.8
17	62.6	52	125.6
18	64.4	53	127.4
19	66.2	54	129.2
20	68.0	55	131.0
21	69.8	56	132.8
22	71.6	57	134.6
23	73.4	58	136.4

Centigrade	Fahrenheit	Centigrade	Fahrenheit
59	138.2	94	201.2
60	140.0	95	203.0
61	141.8	96	204.8
62	143.6	97	206.6
63	145.4	98	208.4
64	147.2	99	210.2
65	149.0	100	212.0
66	150.8	110	230.0
67	152.6	120	248.0
68	154.4	130	266.0
69	156.2	140	284.0
70	158.0	150	302.0
71	159.8	160	320.0
72	161.6	170	338.0
73	163.4	180	356.0
74	165.2	190	374.0
75	167.0	200	392.0
76	168.8	210	410.0
77	170.6	212	414.0
78	172.4	220	428.0
79	174.2	230	446.0
80	176.0	240	464.0
81	177.8	250	482.0
82	179.6	260	500.0
83	181.4	270	518.0
84	183.2	280	536.0
85	185.0	290	554.0
86	186.8	300	572.0
87	188.6	310	590.0
88	190.4	320	608.0
89	192.2	330	626.0
90	194.0	340	644.0
91	195.8	350	662.0
92	197.6		
93	199.4		

	Metric Units	U.S. Equivalents
Lengths	1 millimeter	0.03937 inch
	1 centimeter	0.3937 inch
	1 meter	39.37 inches or 1.094 yards
	1 kilometer	1093.61 yards or 0.6214 mile
Areas	1 square millimeter	0.00155 square inch
	1 square centimeter	0.155 square inch
	1 square meter	10.764 square feet or 1.196 square yards
	1 square kilometer	0.3861 square mile
Volumes	1 cubic millimeter	0.000061 cubic inch
	1 cubic centimeter	0.061 cubic inch
	1 liter	61.025 cubic inches
	1 cubic meter	35.314 cubic feet or 1.3079 cubic yards
Capacities	1 milliliter (0.001 liter)	0.0338 U.S. fluid ounce
	1 liter	2.1134 U.S. liquid pints
	1 liter	1.0567 U.S. liquid quarts
	1 liter	0.2642 U.S. gallon
Weights	1 gram	0.03527 avoir. ounce or 15.4324 grains
	1 kilogram(1000 grams)	2.2046 avoir. pounds

	U.S. System Units	Metric Equivalents
Lengths	1 inch	25.4 millimeters or 2.54 centimeters
	1 foot	0.3048 meter
	1 yard	0.9144 meter
	1 mile	1.6093 kilometers
Areas	1 square inch	645.16 square millimeters or 6.452 square centimeters
	1 square foot	0.0929 square meter
	1 square yard	0.8361 square meter
	1 square mile	2.59 square kilometers
Volumes	1 cubic inch	16,387.2 cubic millimeters or 16.3872 cubic centimeters
	1 cubic foot	0.02832 cubic meter
	1 cubic yard	0.7646 cubic meter
Capacities	1 U.S. fluid ounce	29.573 milliliters
	1 U.S. liquid pint	0.47317 liter
	1 U.S. liquid quart	0.94633 liter
	1 U.S. gallon	3.78533 liters
Weights	1 grain	0.0648 gram
	1 avoir. ounce	28.35 grams
	1 avoir. pound	0.4536 kilogram
	1 Troy ounce	31.1035 grams

Decimal Equivalents of Fraction

inches	Decimal of an inch	inches	Decimal of an inch
1/64	0.015625	29/64	0.453125
1/32	0.03125	15/32	0.46875
3/64	0.046875	31/64	0.484375
1/20	0.05	1/2	0.5
1/16	0.0625	33/64	0.515625
1/13	0.0769	17/32	0.53125
5/64	0.078125	35/64	0.546875
1/12	0.0833	9/16	0.5625
1/11	0.0909	37/64	0.578125
3/32	0.09375	19/32	0.59375
1/10	0.1	39/64	0.609375
7/64	0.109375	5/8	0.625
1/9	0.111	41/64	0.640625
1/8	0.125	21/32	0.65625
9/64	0.140625	43/64	0.671875
1/7	0.1429	11/16	0.6875
5/32	0.15625	45/64	0.703125
1/6	0.1667	23/32	0.71875
11/64	0.171875	47/64	0.734375
3/16	0.1875	3/4	0.75
1/5	0.2	49/64	0.765625
13/64	0.203125	25/32	0.78125
7/32	0.21875	51/64	0.796875
15/64	0.234375	13/16	0.8125
1/4	0.25	53/64	0.828125
17/64	0.265625	27/32	0.84375
9/32	0.28125	55/64	0.859375
19/64	0.296875	7/8	0.875
5/16	0.3125	57/64	0.890625
21/64	0.328125	29/32	0.90625
1/3	0.333	59/64	0.921875
11/32	0.34375	15/16	0.9375
23/64	0.359375	61/64	0.953125
3/8	0.375	31/32	0.96875
25/64	0.390625	63/64	0.984375
13/32	0.40625	1	1.0
7/16	0.4375		

Conversion Constants

To Change:	To:	Multiply by:
Inches	Feet	0.0833
Inches	Millimeters	25.4
Feet	Inches	12
Feet	Yards	0.3333
Yards	Feet	3
Square inches	Square feet	0.00694
Square feet	Square inches	144
Square feet	Square yards	0.11111
Square yards	Square feet	9
Cubic inches	Cubic feet	0.00058
Cubic feet	Cubic inches	1728
Cubic feet	Cubic yards	0.03703
Cubic yards	Cubic feet	27
Cubic inches	Gallon	0.00433
Cubic feet	Gallons	7.48
Gallons	Cubic inches	231
Gallons	Cubic feet	0.1337
Gallons	Pounds of water	8.33
Pounds of water	Gallons	0.12004
Ounces	Pounds	0.0625
Pounds	Ounces	16
Inches of water	Pounds per square inch	0.0361
Inches of water	Inches of mercury	0.0735
Inches of water	Ounces per square inch	0.578
Inches of water	Pounds per square foot	5.2
Inches of mercury	Inches of water	13.6
Inches of mercury	Feet of water	1.1333
Inches of mercury	Pounds per square inch	0.4914
Ounces per square inch	Inches of mercury	0.127
Ounces per square inch	Inches of water	1.733
Pounds per square inch	Inches of water	27.72
Pounds per square inch	Feet of water	2.310
Pounds per square inch	Inches of mercury	2.04
Pounds per square inch	Atmospheres	0.0681
Feet of water	Pounds per square inch	0.434
Feet of water	Pounds per square foot	62.5
Feet of water	Inches of mercury	0.8824
Atmospheres	Pounds per square inch	14.696
Atmospheres	Inches of mercury	29.92
Atmospheres	Feet of water	34
Long tons	Pounds	2240
Short tons	Pounds	2000
Short tons	Long tons	0.89285

Feet Head of Water to PSI

Head Feet	Pounds Per Square Inch	Head Feet	Pounds Per Square Inch
1	0.43	100	43.31
2	0.87	110	47.64
3	1.30	120	51.97
4	1.73	130	56.30
5	2.17	140	60.63
6	2.60	150	64.96
7	3.03	160	69.29
8	3.46	170	73.63
9	3.90	180	77.96
10	4.33	200	86.62
15	6.50	250	108.27
20	8.66	300	129.93
25	10.83	350	151.58
30	12.99	400	173.24
40	17.32	500	216.55
50	21.65	600	259.85
60	25.99	700	303.16
70	30.32	800	346.47
80	34.65	900	389.78
90	38.98	1000	433.00

NOTE: One foot of water at 62°F equals .433 pound pressure per square inch. To find the pressure per square inch for any feet head not given in the table above, multiply the feet head by .433.

Useful Formulas

Geometric Properties: A = Area; A1 = Surface area of solids; V = Volume; C = Circumference

Rectangle

$A = HB$

Circle

$A = \pi R^2$

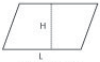
$C = \pi D$

$R = D / 2$

Ellipse

$A = \pi AB$

$C = 2\pi\sqrt{\frac{A^2 + B^2}{2}}$



Parallelogram

$A = HL$

Sector of Circle

$A = \pi R^2 \frac{\alpha}{360}$

$L = \pi R \frac{\alpha}{180}$

$\alpha = 57.296 \frac{L}{R}$

$R = 57.296 \frac{L}{\alpha}$

Sphere

$A = 4\pi R^2$

$V = \frac{4\pi R^3}{3}$

Triangle

$A = \frac{BH}{2}$

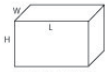
Cone

$A = \pi R(S + R)$

$V = \frac{\pi}{3} R^2 H$

Trapezoid

$A = H \frac{L_1 + L_2}{2}$



Rectangular Solid

$A1 = 2 (WL + LH + HW)$

$V = WLH$

Elliptical Tanks

$A1 = 2\pi\left(AB + H\sqrt{\frac{A^2 + B^2}{2}}\right)$

$V = \pi ABH$

Cylinder

$A1 = 2\pi R(H + R)$

$V = \pi HR^2$

For Above Containers:

Capacity in gallons = $\frac{V}{231}$ when V is in cubic inches Capacity in gallons = 7.48 x V when V is in cubic feet

Definition of Terms

Accelerator – Any of a number of chemicals added to the resin, singly or in combination, which speed the hardening process or cause the hardening to occur (hardener, catalyst, curing agent, promoter).

Adapter – A fitting used to join two pieces of pipe, or two fittings, which have different joining systems.

Adhesive – A material formulated to bond together pipe and fittings resulting in high strength and corrosion resistant fabrications.

Bell and Spigot – A joining system in which two truncated conical surfaces come together and bond adhesively. The bell is the female end. The spigot is the male end.

Bushing – A fitting used to join two different sizes of pipe by reducing the size of the female end of the joint. Joints may come threaded or tapered.

Catalyst – See hardener.

Centrifugal Casting – A process for making pipe in which the resin, fiberglass reinforcement and other ingredients are placed into the interior of a spinning steel rotary mold, forming the pipe through centrifugal force and the application of heat.

Collar – See coupling.

Compressive Force – The force that occurs when a pipe is subjected to crushing loads. Axial compressive forces occur when a piping system is anchored to restrain thermal growth.

Compression Molding – A process for making fittings in which a molding compound is formed and cured into the finished part configuration through pressure and heat in a die.

Concentric Reducer – A pipe fitting used to join two different sizes of pipe while maintaining the same center line.

Contact Molding – A process for making fittings in which cut pieces of fiberglass reinforcement are laid on a mold, saturated with resin, and cured to the finished part shape.

Coupling (collar) – A short heavy wall cylindrical fitting used to join two pieces of the same size pipe in a straight line. The coupling always has female connection ends which can be bell, threaded or a mechanical joining method.

Cure – The hardening of a thermosetting resin system by the action of heat or chemical action.

Cure Stages – Describes the degree to which a thermosetting resin has cross-linked. Three stages, in order of increasing cross linking, include B stage, gelled, fully cured.

Cure Time – The time required for a thermosetting material to react and develop full strength. The time is dependent upon the temperature of the material.

Curing Agent – See hardener.

Cut and Mitered Fittings –Manufactured by cutting, assembling and bonding pipe sections into a desired configuration. The assembled product is then over wrapped with resin-impregnated roving or glass cloth, to provide added strength.

Epoxy Resin – A thermosetting resin, usually made from Bis-phenol A and epichlorhydrin, cured by a variety of agents such as anhydride and amines. These resins contain cyclic ether groups. See thermosetting resin.

FRP – Fiberglass Reinforced Plastic.

Fabmat– A combination of woven roving and chopped strand mat held together with resin binders. Usually used for making contact molded fittings and butt weld joints.

Filament Wound – A manufacturing method for pipe and fittings in which resin impregnated continuous strand roving wraps around a mandrel to achieve high reinforcement concentration and precise filament placement.

Fillers (extender, pigments, inerts; i.e., sand, etc.) – Materials added to a resin which do not affect the cure of the resin but may influence the physical properties of the resin system.

Fitting Types – The classification of fittings by the method of manufacture; i.e., molded, cut and mitered, filament wound, contact molded.

Gel Time – The time it takes for a resin system to harden to a rubber-like state.

Hand Lay-Up – The forming of resin and fiberglass into finished pipe products or fittings by manual procedures. These procedures include over wrap techniques, contact molding, hand molding and others.

Hardener (accelerator, catalyst, curing agent, promoter) – Chemicals added to the resin, single or in combination, which speed up the hardening process, or cause hardening to occur.

Heat Blanket or Heat Collar – An electrical device used to heat a fabrication to reduce cure time.

Hydrostatic Test – A pressure test of a completed fabrication to confirm good quality. Typically, the system is filled with water and held at the selected pressure while checking for leaks.

Impact Resistance – The ability of a part to absorb a striking blow without damage.

Joining (connecting systems) – Any of a variety of methods for connecting two separate components of a piping system together. Included are bell and spigot, threaded and coupled, mechanical devices, etc.

Joint – A term used to describe an individual length of pipe or the actual joining mechanism; i.e., adhesive bonded bell and spigot, threaded and coupled, etc.)

Liner – A generic term used to describe the interior surface in pipe. Generally, liners are resin-rich regions from 0.005 to 0.100 in. thick. Liners may be reinforced with fibrous material such as veil or mat. Liners can provide extra corrosion protection for severe chemical service. They also form a leak barrier (elastomer bladder). The manufacturer may add a liner before, during, or after construction of the pipe wall depending on the manufacturing process.

Matrix – The material used to bind reinforcement and fillers together. This material may be thermoplastic or thermosetting and dictates to a large extent the temperature and chemical service conditions allowable for a pipe or fitting.

Molded Fittings – Pipe fittings formed by compressing resin, chopped fiber and other ingredients in a mold under heat and pressure.

Molding – Any of several manufacturing methods where pressure or compression molding shapes resin and reinforcing materials into final products.

Over Wrap – A method of repair or joining in which fiberglass reinforcement and resin are fabricated over the selected area.

Polyester Resin – Any of a large family of resins which are normally cured by cross linking with styrene. The physical and chemical properties of polyester resins vary greatly. Some have excellent chemical and physical properties while others do not. Vinyl esters are a specific type of polyester resin. Other polyester resins with properties suitable for use in the manufacture of fiberglass pipe include: isophthalic Bis-phenol A fumarate and HET acid polyesters. Each type of resin has particular strengths and weaknesses for a given piping application.

Pot Life – The time available to use thermosetting adhesives after the reactive materials have been mixed.

Pressure Rating – The maximum anticipated long term operating pressure a manufacturer recommends for a given product.

Promoter – See hardener.

Reinforcement – Typically, fibers of glass, carbon or synthetic material used to provide strength and stiffness to a composite material.

The type of fiber used as reinforcement plays a major role in determining the properties of a composite, as does the fiber diameter and the type of sizing used. Terms relating to the physical form of the reinforcement include:

Chopped Fiber - Continuous fibers cut into short (0.125 to 2.0 inch) lengths.

Filament - A single fiber of glass; e.g., a mono filament.

Mats - Coarse fabric sheets made from chopped strands randomly placed and held together by resin binders.

Milled Fibers - Glass fibers, ground or milled, into short (0.032 to 0.125-inch) lengths.

Roving - A collection of one or more filaments wound into a cylindrical package. The typical form of glass fiber used in the manufacture of filament wound pipe.

Veil - Surfacing mat of porous fabric made from glass or synthetic filaments. Used to provide a resin rich layer or liner.

Yarn - Glass fiber filaments twisted together to form textile-type fibers.

Yield - The number of yards of material made from one pound of the product.

Resin (polymer) - As applied to fiberglass pipe, resin is the polymer or plastic material used to bind the glass fibers together.

Resin – The polymer (liquid plastic) material which hardens with cure to provide a solid form, holding the fiberglass reinforcement in place. Resins provide the corrosion resistance in FRP parts.

Saddle – A fitting which is bonded to the exterior of a pipe to make a branch connection.

Shelf Life – The storage time for a material until it becomes unusable.

Socket Joint – A joining system in which two straight cylindrical surfaces come together and bond adhesively.

Stress – The force per unit of cross sectional area. Measured in pounds per square inch (psi). This should not be confused with hydraulic pressures, measured as psig or psia.

Support Spacing (span) – The recommended maximum distance between pipe supports to prevent excessive pipe deformation and bending stress.

Surge Pressure – A transient pressure increase due to rapid changes in the momentum of flowing fluids. Water hammer is one type of surge pressure. Rapid opening or closing of valves often result in a surge pressure or water hammer.

Thermal Conductivity – The rate at which a material transmits heat from an area of high temperature to an area of lower temperature.

Thermal Expansion – The increase in dimensions of a material resulting from an increase in temperature. A decrease in temperature results in a decrease in dimensions commonly called thermal contraction.

Thermosetting Material – A polymeric resin cured by heat or chemical additives. Once cured, a thermosetting resin becomes essentially infusible, (cannot be re-melted) and insoluble. Thermosetting resins used in pipe generally incorporate reinforcements. Typical thermosetting materials include:

- Vinyl esters
- Novolac or epoxy Novolac
- Epoxies
- Unsaturated polyesters

Thrust Forces – Commonly used to describe the dynamic forces resultant from changes in direction of a moving column of fluid. Also used to describe the axial or longitudinal end loads at fittings, valves, etc., resultant from static or continuously applied hydraulic pressure.

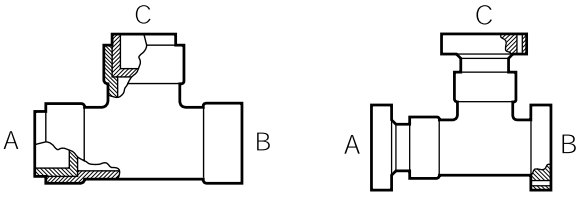
Torque – Used to quantify a twisting moment (torsion) on pipe. Torque is measured as a force times the distance from the force to the axis of rotation. Torque is expressed in foot-pounds (ft-lb) or inch-pounds (in-lb).

Two Holing – A method of aligning flanges onto pipe or fittings so that the bolt circle will mate with the adjoining flange.

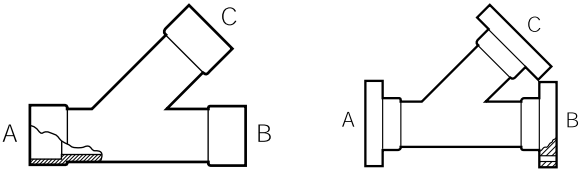
Vinyl Ester – A premium thermalsetting resin system with excellent corrosion resistance. Vinyl ester exhibits high versatility, temperature resistance and excellent corrosion resistance to acids.

Water Hammer – Pressure surges in a piping system caused by sudden change in fluid velocity, such as operation of a valve, pump, or other component.

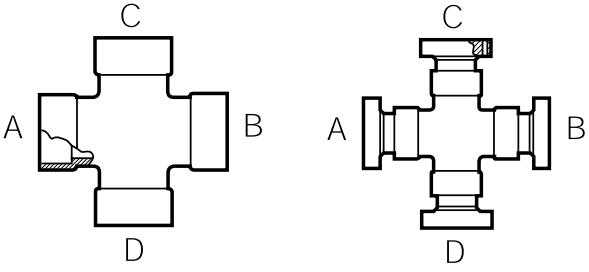
How to Read Flanged or Reducing Fittings



Tee
Run x Run x Branch (AxBxC)



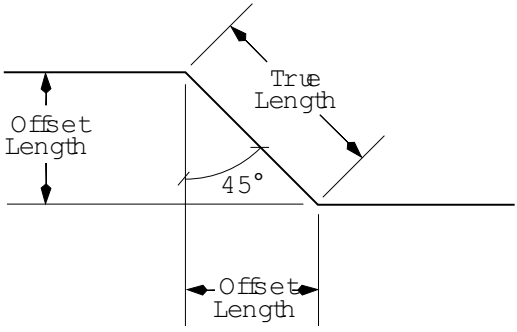
Lateral
Run x Run x Branch (AxBxC)



Cross
Run x Run x Branch x Branch (AxBxCxD)

The above sequence should be used when describing fitting outlets. Drawings or sketches showing outlet types, locations, sizes and dimensional requirements are required for more complicated fitting configurations.

How to Figure a 45° Offset



True Length = offset x 1.414
Offset = true length x .707

Examples:
IF: offset = 12"
12" x 1.414 = 16.968 = 1'-5"
true length = 1'-5"
(to nearest 1⁄16")

IF: true length = 24"
24 x .707 = 16.968 = 1'-5"
offset length = 1'-5"
(to nearest 1⁄16")

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