PIPE INSTALLATION HANDBOOK

Matched Tapered Bell & Spigot Joints

RED THREAD® II
GREEN THREAD®
SILVER STREAK®
F-CHEM®

www.fgspipe.com

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NOV FIBER GLASS SYSTEMS
PIPE INSTALLATION HANDBOOK

Matched Tapered Bell & Spigot Joints

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

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

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

The information supplied by NOV Fiber Glass Systems in its literature must be considered as an expression of guidelines based on field experience rather than a warranty for which the company assumes responsibility. We offer 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.

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Standard Abbreviations

RT	RED THREAD® II piping systems
RTPP	RED THREAD II *Performance Plus* piping systems
GT	GREEN THREAD® piping systems
GTPP	GREEN THREAD *Performance Plus* piping systems
SS	SILVER STREAK® piping systems
FC	F-CHEM® piping systems

Installing fiberglass pipe is easier than installing carbon steel, stainless steel, and lined steel due to its light weight. Learning the proper methods to prepare and make-up bell & spigot 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 NOV Fiber Glass Systems.

Installation videos are available for viewing on our web site at www.smithfibercast.com or www.fgspipe.com.

SAFETY

This 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.

PART I
PIPE PRODUCTS

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.

NOV Fiber Glass Systems' 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.

PIPE GRADES

RED THREAD II &
RED THREAD II *Performance Plus*
Epoxy pipe grade that provides long service life, lightweight and corrosion resistance. Used for light chemical services in salts, solvents and pH 2 to 13 solutions up to 210° F and pressures to 450 psig. Available in 2”-24” pipe sizes. T.A.B. (Threaded and Bonded bell & spigot) is the primary joining method for 2”-6” diameter pipe. Matched tapered bell & spigot joining method is used for 8”-24” pipe.

GREEN THREAD &
GREEN THREAD *Performance Plus*
Epoxy pipe with 15-35 mil resin-rich liner that provides excellent chemical resistance to dilute acids and caustics. Rated for temperatures up to 225°F and pressures to 450 psig. Matched tapered bell & spigot connection is provided on all 1”-24” pipe sizes.

SILVER STREAK
Custom filament wound pipe is specially designed for abrasive and corrosive services found in flue gas desulfurization. It is a proprietary blend of epoxy resin and abrasion-resistant additives. Rated for temperatures to 225°F and 225 psig. Available in 2”-24” pipe sizes.

F-CHEM
Custom filament wound construction offers more flexibility in resin systems, corrosion barriers and wall thickness than our standard products. Rated for temperatures to 250°F and 150 psig. Let us assist you in selecting the right pipe for a specific application. Available in 1”-72” pipe sizes. Joining methods include plain end butt and wrap, O-ring bell & spigot or matched tapered bell & spigot.

FITTINGS

Fittings are color coded. Green Thread fittings are green and may be used with Red Thread II and Green Thread pipe. Silver Streak fittings are black. F-Chem fittings are color matched to the pipe. Be sure to use the correct grade of pipe and fittings for your service. Consult Fittings & Accessories Bulletins for pressure rating limits on various fittings. The lowest rated fitting determines the system pressure rating.

Most compression-molded fittings have a center line dot or cross which will assist you in making measurements.

ADHESIVES

Our 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. Detailed instructions for adhesives are provided with each kit. Read these instructions thoroughly and follow the recommended procedures. The cure time and pot-life of the adhesive is dependent on temperature. Refer to the adhesive instructions. 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 14.

ADHESIVE SELECTION

Standard adhesive kits are designed to be used with specific piping systems as shown in Table 2.

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 1 below.

TABLE 1. Adhesive Estimated Pot Life

Pipe Resin Systems	Adhesive	Pot Life @ 70°F (min.) (see note)	Pot Life @ 90°F (min.) (see note)
Epoxy	2000	20	12
Epoxy	7000	25	15
Epoxy	8000	15	8
Vinyl Ester	CL-100	20	10

NOTE: Pot life is the time available for fabrication. Times may vary depending upon temperature, humidity, quantity mixed, etc.

TABLE 2. Adhesive Selection **Refer to Bulletin No. D4000 for more information**

Use with these Piping Systems	Max. Temp.	Kit Nbr.	Number of Bonds per kit													
			1"	**1 1/2"**	**2"**	**3"**	**4"**	**6"**	**8"**	**10"**	**12"**	**14"**	**16"**	**18"**	**20"**	**24"**
RTII/GT PERF. PLUS	200°F	2014			18	15	13	5	2	1				1/2	1/2	
		2069						8	4	3	2	2	1	1	3/4	1/2
RED THREAD II (Joints Per Can)	150°F	7014			25	18	10	6	3	2	1					
		7024			9	6	4	2	1							
		7069						8	4	3	2	2	1			
RED THREAD II GREEN THREAD SILVER STREAK	225°F	8014	45	27	21	15	8	5	3	2	1			1/2	1/2	
		8024	20	12	9	6	4	2	1							
		8069						8	4	3	2	2	1	1	3/4	1/2

			Number of Bonds per kit									
			14"	**16"**	**18"**	**20"**	**24"**	**30"**	**36"**	**42"**	**48"**	**54"-72"**
F-CHEM	200°F	CL-100	1 1/2	1 1/2	1	1	3/4	1/2	1/3	1/4	1/5	Contact the factory

FABRICATION ACCESSORIES

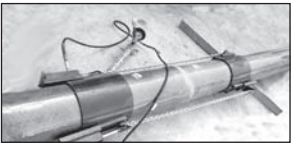
Heat Collars and Heat Blankets:
We offer high temperature heat collars and silicone heat blankets for use in curing of adhesive joints. The blankets and collars have a pre-set thermostat which controls the temperature of the unit. See page 44 for heat collar page 54 for heat blanket cure times for adhesive joint fabrications.

Heat Guns: High wattage electric heat guns are also available to heat F-CHEM adhesive joints. The heat guns are 1600 watt capacity.

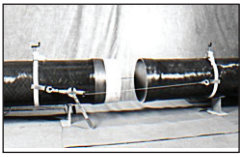
Heat Packs: A heat pack unit consisting of ties and reactants in a plastic bag attached to foil paper is also available. Heat packs will cure joints within one hour.

Tapering Tools: Matched tapered joints require various tools for making the tapered spigot in the field (RT, GT, SS). Refer to Table 6 on page 28 for selection of proper tapering tool.

Come-Along: Specifically designed hydraulic come-alongs are available for 8”-24” piping systems (RT, GT, SS). Especially useful for long straight runs of pipe.



Manual Come-Along: Kit consists of two manual cable puller come-alongs and one strap clamp kit. It is a mechanical aid used to join larger diameter piping. The come-along is most useful for 8”-16” pipe sizes to aid in the alignment and landing of the spigot end into the bell.

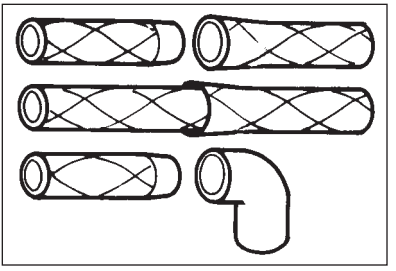


Strap Clamp Kit: We offer Strap Clamp Kits that can be used in conjunction with come-alongs for bonding 8”-24” fittings.

JOINING SYSTEMS

Bell and Spigot Joint: The adhesive bonded, tapered bell and spigot joint is a primary joining method for the following products:

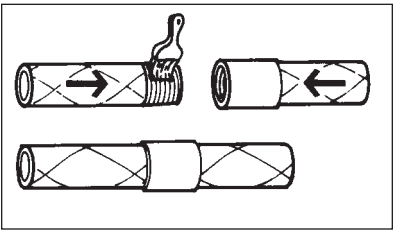
1"-24" Green Thread piping and pipe to fittings
2"-24" Red Thread II piping and pipe to fittings
2"-24" Silver Streak pipe to fittings
4"-72" F-Chem piping*
*Pipe to pipe joints also available in butt & wrap.



Pipe is supplied with one end tapered (the spigot) and the other end belled (integral bell or factory bonded coupling) to accept a tapered spigot. The joint is made by applying adhesive which, when cured, is compatible with the piping systems for joint strength and corrosion resistance.

T.A.B. (Threaded and Bonded) Joint: The T.A.B. joint is the primary joining method for the following product:

2"-6" RED THREAD II piping and pipe to couplings.



The joining system combines both threads and adhesives on the bonding surfaces. The mechanical locking action of these promotes positive makeup which prevents backout during adhesive curing. Standard tapered bell fittings are used with this system.

PART II
SITE CONSIDERATIONS

STORAGE AND HANDLING

A. 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.

Our 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.

The 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 for any damage.** Do not use damaged pipe unless inspected and approved by a NOV Fiber Glass Systems' representative. If impact damage occurs, the damaged areas may be recognized by a star type fracture on

the pipe. Pipe that has been damaged should have a length cut away approximately one foot either side of the impacted site.

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.

B. Adhesive

Vinyl ester adhesives can be damaged by storage in warm places. It is recommended that CL-100 adhesive 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.

Material Safety Data Sheets (MSDS) are available at http://www.fgspipe.com

TOOLS, EQUIPMENT and SUPPLIES REQUIRED FOR INSTALLATION

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

- Pipe Stands, Jacks, Chain Vise, Come-along & strap clamp kit
- Hand Tools
  - Level - Marking Pen - Tape Measure - Pipe Wrap
  - Hacksaw (22-28 teeth/inch)
  - Tapering tool (See pages 26-28)
  - Shop hammer, 3 lbs., and a 2x4 block of wood (for 1”-6” RT, GT, SS)
- Power Tools
  - Power tapering tools (See pages 26-28)
  - Circular power saw with a grit edge abrasive blade, aluminum oxide, carbide or diamond
  - Jigsaw with carbide abrasive blade or fine-tooth metal cutting blade
  - Heat gun, heat blanket or collar
  - T.A.B. wrenches (for 2”-6” T.A.B. joint piping systems)
- Expendables
  - Clean, Dry, Lint-Free Shop Cloths
  - Sandpaper Disc/Emery Cloth (80-120 grit for RT, GT, SS), (30-60 grit for F-Chem)
  - Impermeable gloves
  - Chemical splash goggles

NOTE: You must use the proper tool for tapering each size and type of pipe (see pages 26-28).

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

- 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 vehicle.
- Heat assisted curing
  - Electric heating collars or blankets
  - Chemical heat packs

Additional equipment for 8"-24" pipe assembly (RT, GT, SS):
- Hydraulic come-along or two come-alongs with manila rope or nylon slings (for reduced slippage)
- Strap clamp kit
- Sledge hammer, 12-16 lbs., and a 4 x 4 block of wood

Additional equipment for applying saddles:
- Power sander with 30-60 grit sanding disc (preferred for 6" and larger saddles).
- Hose clamps

SUGGESTED LABOR TIMES FOR BELL X SPIGOT PIPING SYSTEMS

Pipe Size	Placing in Hangers (Min/Ft) (1)	Set Up (Min.) (10)	Scribe & Cutting (Min/Jt) Hand/ power	Hand Tapering (Min/Jt)	Power Tapering (Min/Jt)	Joint Makeup (Min) (7/8)
1"	.7	3.0	1.33/1.25	1.0	.25 (2)	1.0
1 1/2"	.7	3.0	1.33/1.25	1.5	.25 (2)	1.0
2"	.7	3.0	1.50/1.25	2.0	.25	1.5
3"	.7	3.0	2.0/1.33	3.0	.25	2.0
4"	.8	4.0	5.0/2.5	4.0	.25	3.0
6"	1.0	5.0	7.0/3.0	5.0	2.5 (3)	4.0
8"	1.2	7.0	4.5/3.5	22.0	8.0 (4,5,9)	5.0
10"	1.4	7.0	NA/5.0	35.0	10.0(9)	6.0
12"	1.7	8.0	NA/5.0	40.0	12.0(9)	8.0
14"	2.3	9.0	NA/5.0	NA	12.0 (5,9)	10.0
16"	2.3	10.0	NA/6.0	NA	12.0(9)	12.0
18"	2.5	12.0	NA/8.0	NA	25.0 (6,9)	14.0
20"	3.0	12.0	NA/8.0	NA	28.0 (6,9)	16.0
24"	3.0	14.0	NA/10.5	NA	30.0 (6,9)	20.0

Table 2.1

(1) Placing in hangers figures are based on one-worker operation for 1"-4"; two workers for 6"-10"; three workers for 12"-24". Total times should be figured by multiplying figures given by workers needed per operation.

(2) 2000 series Power Tools

(3) 2"-6" Hand Tapering Tool
(4) Individual Tapering Tool
(5) 8"-16" Taper/Scarf Tool
(6) 18"-24" Taper Tool
(7) Each joint makeup calculation includes cleaning, sanding, applying adhesive and proper engagement. Allow three minutes for mixing adhesive.
(8) The units (time) listed above are based on using experienced crews on fitting intensive runs. For straight run pipe, contact your local representative.
(9) Time doubles for Performance Plus products.
(10) Includes set up for hydraulic or manual come-along and setting pipe stand levels.

These numbers are based on installations using experienced crews in typical installation conditions. They do not include extreme weather conditions, time used for gathering supplies and tools, break time, manpower issues, etc. Assume 6 hours of productive labor for every 8 hours worked. Adjustment factors should be applied to these base units to compensate for prevailing production and job conditions. Because of all the variables involved, NOV Fiber Glass Systems is not responsible for any differential between these numbers and actual results.

SUGGESTED CREW SET-UP AND ASSEMBLY

Manpower requirements change depending on whether the installation is simple, consisting of long, straight runs, or complex. It also depends on pipe size, installation temperature, and other similar influences. Following are some general guidelines that are applicable to most installations. If you have any questions, please contact an NOV Fiber Glass Systems representative for information.

A. Suggested Crew Size for 1" - 6" straight run pipe (long runs)

A three-worker crew is the minimum recommended crew size. A four-worker crew is sometimes more efficient, even when installing 1" - 6" diameter pipe.

Man # Crew Description

#1 Clean/prep/align

Removes end caps, sands and cleans joint and aligns pipe for bonding.

#2 Adhesive mixer/bonder

Mixes adhesive and applies to bell and spigot.

#3 Assembly man

Helps make up joint and checks for lock up.

#4 Pre-heat/prep/supplies

(optional through 4"; recommended on 6")

Pre-heats joints and helps keep pipe aligned. Also applies heat collars during cool weather. (All help in moving supplies and equipment from joint to joint.)

B. Suggested Crew Size for 8" - 48" straight run pipe (long runs)

A six or seven crew members is recommended.

Man # Crew Description

#1 Clean/prep/align

Removes end caps, sands and cleans joint and helps align joint for insertion.

#2 Adhesive mixer/bonder

Mixes adhesive and applies to bell and spigot. Marks insertion depth and determines when joint is locked up. Assists with come-along.

#3 Adhesive mixer/Bonder

Helps #2 with adhesive and assists with come-along.

#4 Pre-heat/alignment man

Pre-heats joints, helps align joints and assists with come-along.

#5 Alignment man

Sets level of pipe and aligns joint for proper insertion; directs tractor driver.

#6 Truck driver/Supply man *(optional)*

Drives supply truck and assists with all aspects of installation. Also coordinates heat collars during cool weather and ice chest during hot weather.

#7 Tractor Operator
Operates side boom tractor, trac hoe or backhoe.
(All help in moving supplies and equipment from joint to joint.)

C. In more complex pipe assemblies, the crew size will depend on the amount of tapering and prefabrication needed. In most cases, a three-worker crew is the minimum for any size piping installation. In some instances (small jobs with only a few joints) only one or two crewmen will be required.

RECOMMENDATIONS FOR FABRICATION IN ADVERSE WEATHER CONDITIONS

The 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 F-CHEM adhesive in ice chest prior to mixing.
4. Keep mixed adhesive in an ice chest with sealed bag of ice or ice pack.
4. Refer to the field fabrication instructions supplied in the adhesive kit for the proper amount of catalyst in CL-100.

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.

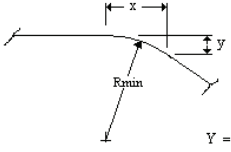
Extreme Moisture

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.

BURIED INSTALLATIONS

Minimum Bending Radius Layout



$$Y = R \cdot \left(1 - \cos\left(\operatorname{asin}\left(\frac{X}{R}\right)\right)\right)$$

Where:
X = Run, ft(m)
Y = Offset, ft(m) π)
R = minimum bend radius, ft(m)
(trigonometric function based on radians)

These are general guidelines only. For more details see Engineering and Piping Design Guide E5000. For installations using UL listed RED THREAD IIA piping see special instructions contained in Manual No. B2160.

Offset Bending Allowance for GREEN THREAD & RED THREAD II Pipe

Size (In)	X (Ft) (straight run)	Y (Ft) (offset from straight run)
2	10	0.8
	20	3.7
	30	9.0
	40	18.1
3	10	0.5
	20	2.5
	30	5.9
	40	11.1
4	10	0.4
	20	1.9
	30	4.4
	40	8.2
6	20	1.2
	30	2.9
	40	5.4
	50	8.6
8	20	0.8
	40	4.0
	60	9.4
	80	17.5
10	20	0.7
	40	3.2
	60	7.5
	80	13.8
12	20	0.6
	40	2.7
	60	6.3
	80	11.6
14	20	0.5
	40	2.4
	60	5.5
	80	10.0
16	20	0.5
	40	2.1
	60	4.8
	80	8.8

Size (In)	X (Ft) (straight run)	Y (Ft) (offset from straight run)
18	20	0.4
	40	1.9
	60	4.3
	80	7.9
20	20	0.3
	40	1.7
	60	3.9
	80	7.1
24	20	0.3
	40	1.4
	60	3.2
	80	5.9

TABLE 3. Burial Depths*

Product	Minimum (Ft.)	Maximum (Ft.)
1" - 4" RED THREAD II	2	15
6" - 24" RED THREAD II	3	15
1" - 12" GREEN THREAD	2	15
14" - 24" GREEN THREAD	3	15
1" - 12" SILVER STREAK	2	15
14" - 24" SILVER STREAK	3	15
F-CHEM Custom Piping**	3 - 5	12 - 20

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

** F-CHEM is designed for specific burial applications according to AWWA C950.

A. Burial Depth

1. Minimum Burial Depth
   Minimum depth in unpaved areas for pipe subjected to vehicular loads depends on pipe grade, pipe size, vehicle axle weight, and the bedding material. With a standard legal axle load of 34,000 lbs., the minimum depth of cover (from the top of the pipe to the surface)

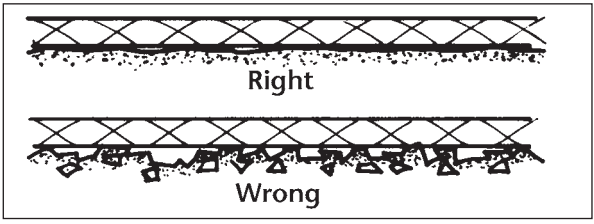
for moderately compacted non-clay bearing soils is shown in Table 3.

The pipe should always be buried below the frost line.

2. Maximum Burial Depth
   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 3.

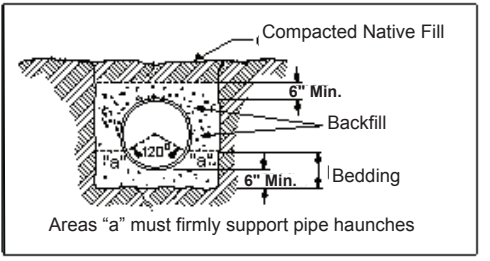
B. Trench Preparation

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.



C. 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 undisturbed trench bottom if the native soil meets the requirements of a recommended bedding material (refer to Table 4). 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.



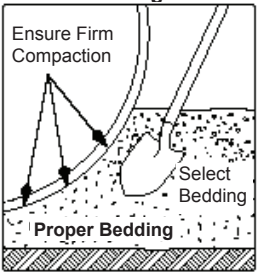
Areas “a” must firmly support pipe haunches

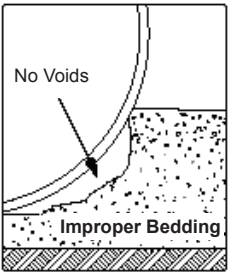
TABLE 4. Recommended Bedding Materials	
Bedding Material	Compaction Proctor Density
Crushed rock or pea gravel 3/4” maximum size	Not Required
Coarse-grained sand or soil with little or no fines	75-85%
Coarse-grained sand or soil with more than 12% fines	85-95%
Sand or gravel with more than 30% coarse-grained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

D. 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 4) 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.

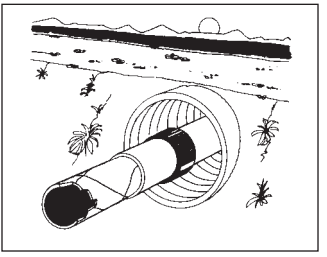
Consult the factory if the pipe will be subject to vacuum or high water tables.





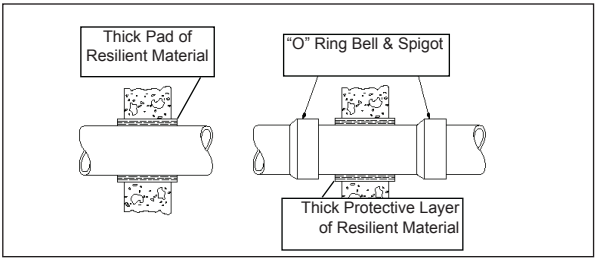
E. Road Crossings

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.



F. 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.



G. Timing

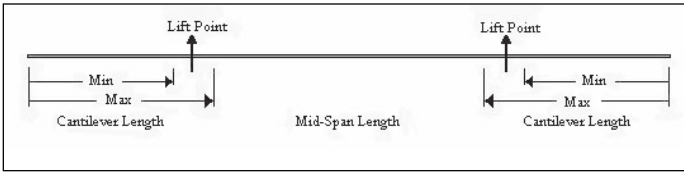
Test and cover the pipe as soon as possible to reduce the-chance of damage to the pipe, floating of the pipe due to flooding, or shifting of the line due to cave-ins.

H. Two Point Lifting of Red Thread II

TIhis table provides information concerning safe lift points for RTII during installation. The following table has been compiled for two lift points and the maximum length of pipe that may be safely lifted and the critical location of the lift points.

TABLE 4.H

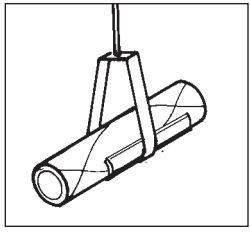
Nominal Size (In)	Pipe Lengths (Feet)		Cantilever Length (Feet)		Mid-Span Lengths (Feet)	
	Number	Length	Min.	Max.	Min.	Max.
8	3	120	24	26	68	72
10	3	120	20	28	64	80
12	3	120	22	31	58	76
14	3	120	22	31	58	76
16	3	120	20	35	50	80
18	3	120	19	36	48	82
20	4*	160	31	37	86	98
24	4*	160	29	40	80	102



ANCHORS, GUIDES AND SUPPORTS

A. Pipe Hangers

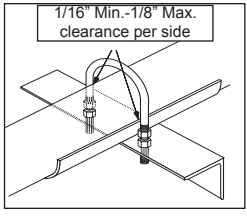
Pipe hangers such as those shown are often used to support pipe in buildings and pipe racks. However, the use of too many hangers in succession can result in an unstable line when control valves operate, and during pump start-up and shutdown. To avoid this condition, the designer should incorporate auxiliary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



B. Pipe Guides

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.

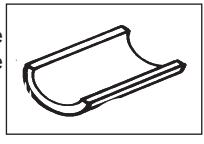


Primary and secondary guides, i.e., those immediately adjacent to expansion joints, are spaced more closely than intermediate guides. Refer to Manual No. E5000, *Engineering & Piping Design Manual,* for details.

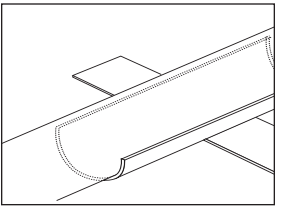
Piping entering expansion joints or expansion loops require additional guides. Refer to Manual No. E5000, *Engineering & Piping Design Manual* for details.

C. Pipe Supports:

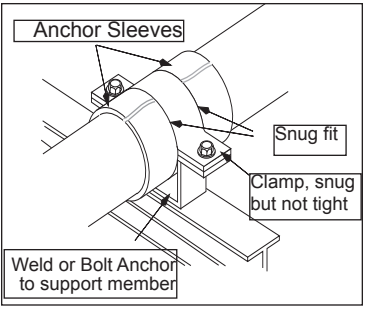
Piping supports for the pipe should be spaced at intervals as shown in the product bulletins.



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 74.



D. Pipe Anchors: 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.



Caution: Do not install more than one expansion joint between the same two anchors in any straight pipe section.

Do not anchor the pipe by applying external pressure as point loads, such as a "U"-bolt, directly to the bare pipe. Refer to Manual No. E5000, *Engineering & Piping Design Guide*, for a thorough discussion on supports, anchors and guides.

PART III
GENERAL INSTALLATION INSTRUCTIONS

IMPORTANT • READ THIS FIRST

Before beginning the actual assembly procedures, read and make sure all installers thoroughly understand the following instructions.

All bonding surfaces must be clean, dry and factory fresh in appearance before applying adhesive. When end caps have been lost, surfaces will weather and result in loss of bond strength When surfaces are weathered, re-taper (RT, GT, SS) spigots. Sand bells and F-CHEM spigots to achieve a factory fresh appearance. (Note: T.A.B.™ couplings that have weathered must be replaced.)

Matching tapered bell and spigot joints require a very thin adhesive bond line for maximum strength and durability. The adhesive used with tapered joints is very strong when used in bond lines a few thousandths of an inch thick. The same adhesive may be brittle in thick sections resulting in poor bond strength. To achieve a thin bond line, the matched tapered angles of the joint are designed to mechanically "lock-up" when wedged together.

Using mechanical force assures "lock up" and a thin bond line. Hammering a wooden block placed against the bell end of pipe, or using mechanical devices such as come-alongs should be used to "lock up" the joint.

Note: For T.A.B. joints, special T.A.B. wrenches are required to achieve the mechanical lock up in the joint.

Adverse weather conditions require special precautions when bonding pipe. (See page 14, *Recommendations for Fabrication in Adverse Weather Conditions*) The adhesive is very viscous (thick) when cool or when applied to cool pipe. The thick adhesive can actually be stiff enough to prevent joint "lock up." When the adhesive is hot or when it is applied to hot pipe, the available working time may be significantly reduced.

Matched tapered bell and spigot joints that are not "locked up" can fail prematurely.

CUTTING FIBERGLASS PIPE

NOV Fiber Glass Systems' pipe should be cut using one of the methods referred to under Tools and Equipment on page 10.

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.

Note: For integral joint (IJ) bell ends, the bell end must be cut off before tapering. Measure the O.D. of the pipe near the bell end until you see the O.D. start to get larger. Cut the pipe at this point. Depending on pipe size the distance from the end of the bell can vary anywhere from 12" to 36".

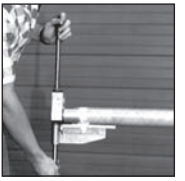
PART IV
FABRICATION OF RED THREAD II, GREEN THREAD AND SILVER STREAK PIPE AND FITTINGS

TAPERING PIPE

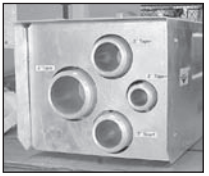
Various tools are available from NOV Fiber Glass Systems for making the tapered spigot in the field.

To reproduce a standard taper, the tapering tool must be marked or adjusted. The process varies depending on the tool being used and the product being tapered. Please refer to indi-vidual tool instructions for tapering.

Refer to Table 6 on page 28 for specific bulletin number and proper taper angle for each size and type of pipe. **Do not** taper over the bell end of integral joint pipe. See page 25 for cutting instructions.



A. 1"-6" Tool (Bulletin F6600) - A hand-held tool that can be adapted for power when a large number of tapers is necessary. Different piping systems require different mandrels.

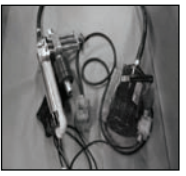


B. Model 2100/ 2102 Tool (Bulletin F6625/ F6624) - Power tool for tapering and scarfing RED THREAD II and RED THREAD IIA piping.

C. Model 2300 Tool (Bulletin F6627) - Power tool especially designed for tapering 1" - 4" GREEN THREAD piping.

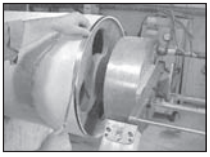
D. 8", 10", or 12" Tapering Tool (Bulletin F6608 or F6612) - These tools are designed for manual or power (i.e., Ridgid 300 or 700 power drive or equal) operation; there is a tool for each size pipe.

E. 2"-12" Remote Power Tool (Bulletin F6601) - Tapers 2"-12" pipe. Must change angle for 8" and larger pipe. Recommended for all 6" tapers.



Additional material will be needed:
1. Sturdy work bench (preferably with a metal top) or stand to hold the tool
2. Two 20" long pieces of 1" diameter steel pipe. Mount these on top of the bench parallel to each other, on a 2-foot center, extending off the bench 12".
3. Two adjustable pipe stands with hard rubber rollers at 90 degree angle to pipe, i.e. the stand must allow the pipe to rotate.
4. This tool requires approximately 3,000 watts of 115 vac power for operation (30 amp breaker). We recommend 5,000 watts (50 amp breaker). As the length of extension cords increases, the power lost in the cord increases. Table 5 shows maximum allowable lengths for various size cords.

F. 8"-16" Taper/Scarf Tool (Bulletin F6622) - This is an electrically powered tapering tool. The tool comes with different size mandrels to taper 8"-16" pipe.



G. 18"-24" Tapering Tool (Bulletin F6621) - This is an electrically powered tapering tool. The tool comes with different size mandrels to taper 18"-24" pipe.

Note: Some tools may be used with other pipe systems with special-order tooling. In these cases, supplemental tool instructions are also available. Be sure to specify which pipe system you will be tapering when ordering tools.

TABLE 5. Extension Cord Length

Wire Size (AWG)	Suggested Length (Ft.)	Maximum Length (Ft.)
12	20	22
10	30	36
8	50	57

TABLE 6. Tapering, Scarfing and Cutting Tool Reference Chart

Tool	Product	Tool Taper Angle	Bulletin #	Comments
1" - 6" Hand Tapering	RT GT	1" = 3°; 1 1/2 = 2 1/2° 2" - 6" = 1 3/4°	F6600	Specify product to receive correct mandrels. Order scarfing adapter kit for sec. cont. Power adapter separate. Uses Ridgid® 700 or equivalent power drive with a Ridgid 774 adapter.
2100 Power	RT	1 3/4°	F6625	Tapers 2" & 3"; Scarfs 3" & 4"
2102 Power	RT	1 3/4°	F6624	Tapers 2" - 4"; Scarfs 3"
2300 Power	GT	1 3/4°	F6627	Tapers 2" - 4",
2700 Power	SS	1 3/4°	F6632	Tapers 2"-4" Silver Streak
8" Tapering or Scarfing Tool	RT/GT GT MOS	0 or 1° 0°	F6608 Taper F6609 Scarf	Tapers and scarfs. Order scarfing adapter kit for S.C. Uses Ridgid 700 or equivalent power drive with a Ridgid 774 adapter.
10" & 12" Taper or Scarfing Tool	RT/GT GT MOS	0 or 1° 0°	F6612 Taper F6613 Scarf	Tapers and scarfs. Order scarfing adapter kit for Secondary Containment. Uses Ridgid 700 or equivalent power drive with a Ridgid 774 adapter.
6"-12" CERAM CORE	CERAM CORE	None	F6620	Scarfs 6"-12" Ceram Core
8"-16" Single Point Taper Tool	8"-16" RT, GT, MOS	0 or 1°	F6622	Tapers or scarfs 8"-16" RT, GT, SS. Scarfs 8"-12" GT MOS or 8"-16" secondary containment.
2"-12" Remote Power Tool	RT, GT, SS	2"-6" - 1 3/4° 8"-12" - 1°	F6601	Tapers 2"-12" pipe. Must change angle for 8" and larger pipe. Recommended for all 6" Tapers.
18"-24" Taper Tool	RT, GT, SS GT MOS	0 1 1/4°	F6621	Taper 18"-24"

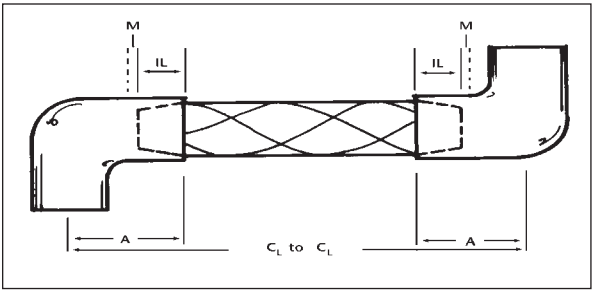
A. Close Tolerance Piping

The tapered bell and spigot system employed by NOV Fiber Glass Systems can be readily used to achieve dimensional accuracy where required by a particular pipe layout. As with any matched taper, minor variations in tolerance in the bell or spigot will affect the insertion depth. In applications where the final make-up length of an assembly is not critical, these variations are of no consequence. However, when the installation is such that close tolerances must be maintained, you must compensate for these variations. It is possible to accurately reproduce tapers (spigots) in the field with the field tapering tools. This provides a means of achieving dimensional accuracy.

Calculation to Achieve a Desired Length

Most close tolerance installations are made to prints calling out C_L to C_L (centerline to centerline) dimensions.

When fabricating to these dimensions, follow these procedures per the figure below .



1. Obtain the centerline to face dimension (A) of fittings to be used from Tables 8 or 9 on pages 33-36.
2. Create an insertion gauge by cutting a short section of pipe; 12" long for small diameters and 18" long for larger diameters. Taper the pipe using the instructions supplied with each tool. Check dry insertion. The insertion length should be within $\pm 1/8$" of a factory spigot insertion.
3. Obtain insertion length (IL) by inserting the gauge (made with the tool being used) into a fitting and measuring. (Note: Measure each end of each fitting, because the insertion may vary for each bell.) You can prepare and use

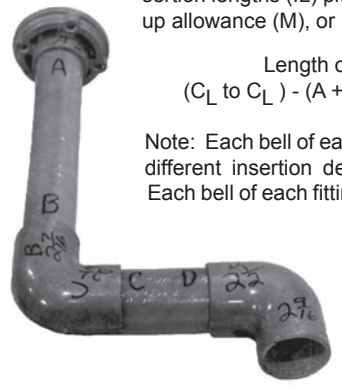
a short nipple as a standard insertion gauge. (Note: You must prepare a new gauge if you change tapering tools or make any changes to the tool you are using.) Always add a make-up dimension (refer to Table 7) to this measurement, since the adhesive will act as a lubricant and allow greater penetration than when the surfaces are dry.

TABLE 7. Approximate Make-up Dimensions (M)*

Pipe Diameter (In.)	Approximate Make-up Dimensions* (In.)
1 and 1 1/2	1/16
2	1/8
3 and 4	3/16
6	1/4
8	3/8
10 and 12	5/8
14	3/4
16	1
18	Use field developed dimensions
20	
24	

*CAUTION: Make-up dimensions depend on the tightness of the dry fit. If the field developed dimensions vary, use field developed dimensions.

4. To achieve a specified C_L to C_L dimension, the length of pipe to cut is equal to the C_L to C_L distance minus the sum of the centerline to face dimension of the fittings ("A" dimension) plus the sum of the measured insertion lengths (IL) plus the sum of the make-up allowance (M), or



$$\text{Length of Pipe to Cut} = (C_L \text{ to } C_L) - (A + A) + (IL + IL) + (M + M)$$

Note: Each bell of each fitting may have a slightly different insertion depth with a standard taper. Each bell of each fitting should be checked with a standard taper and marked. Consult Bulletins No. A1350 or A1355 for fittings dimensions.

JOINT PREP for
RED THREAD II, GREEN THREAD, and SILVER STREAK

All bonding surfaces must be clean and dry before bonding.

- For T.A.B. joints, clean with an acceptable solvent and clean rag. Wire brushes may also be used for cleaning T.A.B. surfaces; however, they must be clean and free of oily contaminates.
- For smooth tapers, sandpaper or solvent (or both) may be used. Sand just light enough to remove any contaminates.
- Use caution as oversanding can change the taper angle or end dimension, and create flat spots on the spigot.
- When surfaces have weathered, sand or retaper spigots and sand bells to achieve a factory fresh appearance. Cut at least 1" from spigots before retapering. T.A.B. couplings must be replaced.
- Bonding surfaces must be dry, so be sure all solvent has evaporated before applying adhesive.

Note: Use of a solvent as a cleaning method is optional. Some alternate cleaning solvents are acetone, methylene chloride, and methyl ethyl ketone. After cleaning, be sure any residual solvent has evaporated before applying adhesive. DO NOT USE SOLVENTS THAT LEAVE AN OILY FILM ON THE BONDING SURFACES.

WARNING: Some degreasers and solvents are extremely flammable. Do not smoke or use near an open flame. Wear eye protection. Be sure to read warning labels on containers.

Never use gasoline, turpentine, or diesel fuel to clean joints.

Solvent containers may be under pressure. Use caution when removing inner seals, especially in warm weather. Use with adequate ventilation.

ADHESIVE MIXING

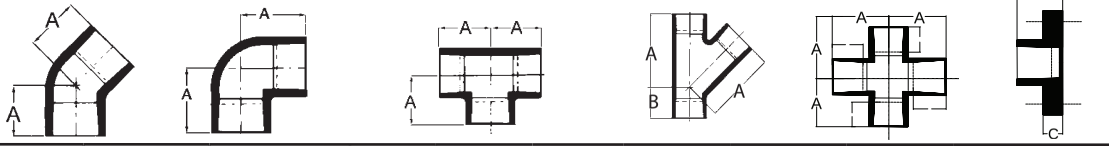
When the weather is cool or the adhesive has been stored in a cool environment (below 70°F), prewarm the adhesive kits. (Do not heat above 100°F!)

1. For epoxy empty all of the contents of the hardener bottle into the can of base adhesive.
2. Mix all of the base epoxy adhesive with all of the hardener. NEVER ATTEMPT TO SPLIT A KIT. Cut through the adhesive with the edge of the mixing stick to assist in mixing the two components.
3. Mix until the adhesive has a uniform color and a consistent flow off the mixing stick. Wipe down the sides, bottom, and under the rim of the can with the mixing stick to assure complete mixture.

Complete information and safety precautions are packaged with each adhesive kit. Review all safety precautions thoroughly before mixing the adhesive.

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.

TABLE 8. Take-off Dimensions for RT, GT Fittings (Contact Company for SS Dimensions)



Size	45° Elbow A	90° Elbow A	Tee A	Lateral A	Lateral B	Cross A	M/FW* B	M/FW* C
1	2 3/8	2 3/4	2 3/4	3 7/8	2 1/2	2 3/4	1 3/4	3/4
1 1/2	2 7/8	3 3/8	3 3/8	5 1/4	3 1/4	3 3/8	1 3/4	3/4
2	2 5/8	3 3/8	3 3/8	6 5/8	2 3/4	3 3/8	2 1/4 / 2 1/8	3/4
3	3 3/4	4 5/8	4 5/8	7 3/4	4 1/4	4 5/8	2 5/8	1 3/8
4	3 7/8	5 1/8	5 1/8	9	4 3/8	5 1/8	2 5/8 / 3 1/2	1 3/8
6	4 3/8	6 1/8	6 1/8	12 1/2	5 3/4	6 1/8	3 / 3 3/4	1 1/2
8	8 1/8	11 5/8	11 5/8	16 1/4	7 3/8	11 5/8	4	1 3/4
10	8 5/8	13 1/8	13 1/8	19 5/8	8 3/4	13 1/8	4 3/4	2
12	9 1/2	14	14	24 3/4	11 3/4	14	5	2 1/4
14	12 1/2	19	19	32 1/2	15 3/4	16	3 1/8	2 1/2
16	13 1/4	20 1/4	20 1/4	35 3/4	17 3/4	17 1/4	3 1/8	2 1/2

***Flanges**
M - Molded
FW - Filament Wound

Dimensions are used to calculate pipe length requirements to meet pipeline center line to center line dimensions.

Table 8.1 Dry insertion depths for standard RED THREAD II and GREEN THREAD pipe and fittings.

Size	90 & 45 Degree Elbows & Tees		Crosses		Laterals		Molded Flanges		FW Flanges	
In.	X-RT	X-GT	X-RT	X-GT	X-RT	X-GT	X-RT	X-GT	X-RT	X-GT
1	-	1	-	1	-	1	NA	1	-	1
1 ½	-	1	-	1	-	1	-	1⅛	-	1⅛
2	1½	1½	1½	1⅝	1½	1⅝	1⅞	1⅝	1½	1⅝
3	1⅝	1⅞	1⅝	1⅞	1⅝	1⅞	1⅞	2	1⅞	2
4	1½	1⅞	1½	1⅞	1½	1⅞	1⅞	2⅛	1⅞	2⅝
6	2⅛	2⅜	2⅛	2⅜	2⅛	2⅜	2½	2⅜	2½	2½
8	3¼	3	3¼	2⅞	3¼	2⅞	2⅞	2¼	3⅜	3⅜
10	3⅜	3	3¼	3	3⅛	2⅞	3¾	3⅜	3	3
12	3¾	3⅜	3⅝	3¼	3¼	3	3¾	3⅜	3	3
14	6⅛	6	3⅝	3⅝	3⅝	3⅝	-	-	2¼	2⅜
16	6⅛	6⅛	3⅞	3⅞	3⅞	3⅞	-	-	1⅞	2

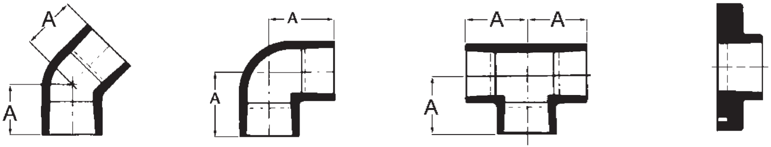
The X values are the nominal dry spigot insertions used to set up tapering tools. The tolerances for dry insertion are ±⅛" for 1"-6" and ±¼" for 8"-16" pipe sizes. The final insertion referred to as the wet locked up position will be larger than the X dimension. Do not use these dry insertion depths for close tolerance piping calculations.

Table 8.2
Take off and nominal dry insertion dimensions for low pressure, 150/225 psig, SILVER STREAK products. Refer to Bulletin A2000 or www.fgspipe.com for more information.

INSERTION DEPTHS FOR SILVER STREAK		
Size	**Coupled/Mitered Fittings**	**Filament Wound Fittings**
2	1⅞	2⅝
3	2 ⅜	2⅞
4	2	3⅛
6	2⅞	2¾
8	3 ½	5¼
10	4⅜	5⅛
12	4⅞	6⅜
14	5½	4½
16	6¼	5⅝

X dimensions are nominal **dry** insertion lengths. Pipe must be driven together and fully locked up to assure full joint strength. Actual insertions should be + ¼" for 8" and larger joints. **Insertion depths are for tool set up only. Do not use insertion depths (x) for close tolerance piping.** Refer to joint assembly instructions for complete information on joint lock up.

TABLE 9. Take-off Dimensions for RT/ GT *Performance Plus* Fittings



Size (In)	45 º Elbow (Long Radius) (In)			90 º Elbow (Long Radius) (In)			Tee (In)			Flanges (In)
	A	x-RT	x-GT	A	x-RT	x-GT	A	x-RT	x-GT	A-Van Stone
8	12½	6	5⅛	19 ½	6	5 ⅛	13 ½	6	5 ⅛	6 ¼
10	14½	6½	6 ½	23 ¼	6 ½	6 ½	15 ¾	6 ½	6 ½	7
12	16½	7	7	27	7	7	17 ¾	7	7	7 ¾
14	17¾	5¾	5 ¾	30	5 ¾	5 ¾	19 ½	5 ¾	5 ¾	8
16	20	5¾	5 ¾	34	5 ¾	5 ¾	21 ½	5 ¾	5 ¾	9
18	24⅞			40			26 ⅜			10 ½
20	29 ⅝			47 ¼			31 ¼			12 ½
24	35 ⅞			57			35			15 ½

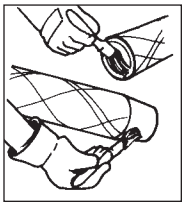
Dimensions are used to calculate pipe length requirements to meet pipeline center line to center line dimensions.

B. 1” - 6” Bell & Spigot Joint

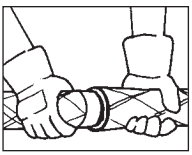
THE SPIGOT MUST BE ALIGNED AND LOCKED IN THE BELL. A cocked or misaligned joint will result in false “lock up” and premature joint failure either during testing or at a later date.

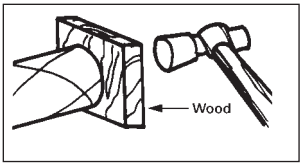
1. When ambient temperature is below 70°F, prewarm the bonding surfaces. Use a hot air gun, propane torch or other clean burning heat source that has a spreader type tip, and apply heat uniformly to bell and spigot until warm to the touch. Check temperature by touching bonding surfaces with the back of your hand. Do not touch with the front of your hand as this may contaminate the joint. If hot to the touch, let cool before applying adhesive. When using a torch to preheat, warm the bell first. It is thicker and will hold heat longer. If an electric heating collar is used to prewarm, place the joint together dry, then heat the O.D. of the bell to avoid contaminating the spigot. **CAUTION:** Do not use chemical heat packs for prewarming.

2. Brush adhesive on both the bell and spigot bonding surfaces, applying a thin uniform coating to each . To minimize contamination, apply adhesive to the bell first. Adhesive should always be worked into the machined surface by applying pressure during application. This will “wet out” the machined surface and maintain the required thin bond line. Be sure that adhesive is deep down into the bell past the insertion depth and that all machined taper surfaces on the spigot and the cut end of the pipe are uniformly covered. Excess adhesive will make the joint more difficult to lock.



3. Align and lock the joint. For 2" or smaller pipe, insert the spigot into the bell until surfaces touch, then push and turn at the same time until a lock is achieved. Only a quarter to a half turn is usually needed. On 3”-6” diameter pipe or on fittings, pushing and turning to lock the joint is impractical and driving force must be used. A hammer may be used to assist in joint lock-up. Place a 2x4 board flat across the bell. The first few raps should be light to prevent any tendency of the joint to back out.





If the adhesive or the pipe surfaces are cool, push and hold for a few seconds to allow time for the adhesive to start flowing out of the tapered joint.

4. Check lock up by moving free end of the pipe in an up and down or side to side motion. The movement must be sufficient to move the joint being checked. No movement should be visible in the joint. If any movement exists, the joint is not properly locked up. Avoid excess movement as this could damage the spigot.

C. 8" - 24" Bell & Spigot Joint

1. Long runs (ditch piping) must be supported at the joint section at all times until fully cured. Lifting near the center of the pipe with a backhoe or side boom tractor without proper support under the joint can cause damage to joints that are not cured. Lifting near the center of the pipe for alignment is acceptable as long as the joint does not support the weight of the piping section. Blocks or skids should be used to support the entire joint section until the joint is fully cured. Install pipe in straight alignment; never install pipe in a bind.

2. **8"-24" hydraulic come-along** is recommended for pipe-to-pipe connections. For more difficult bonding situations in a pipe rack or in tight quarters, a manual come-along kit with strap clamps is available from and is recommended for sizes through 16". All joints 18" and larger **must** use a hydraulic come-along to achieve full joint lock up. All joints pulled together with this type of device must be vibrated during installation to help align the spigot in the bell and prevent a false lock up or cocking of the joint. Refer to Bulletins No. F6618 or F6619 for detailed instructions on hydraulic come-alongs.

   a. When using a hydraulic come-along on 8"-24" pipe, make sure pipe is resting on blocks before come-along collars are removed. Do not remove collars while pipe is still attached to cable or tractor. If collars are resting on blocks after bonding, leave pres-

sure on come-along and lift gently with the chains, just enough to remove collars. Do not place excessive bending stress across the joint.

3. **Strap clamp kits** are available for pipe to fitting connections. When used in conjunction with the hydraulic come-along, a heavy duty band (strap) clamp and two ring belt straps are used to pull the joint together. Refer to Bulletin No. F6641 for detailed instructions on Strap Clamp Kits.

4. **Ratchet-type come-alongs** can be used as an alternative to the hydraulic come-alongs. Use two, one on each side of the joint. Use a heavy-duty strap clamp kit to attach the come-alongs to the pipe. Slings, or 5/8" or larger manila ropes, are also acceptable. A series of half-hitches will grip the pipe when using rope. Allow room to operate the come-alongs by placing the strap clamps, slings or ropes 18"-24" on each side of the joint. Take up come-alongs together so that the joint stays in alignment. Force the joint together until it is solid. Rap the joint together with a 5 lb. dead blow hammer(s) while keeping pressure on the come-alongs to ensure the joint is fully engaged.

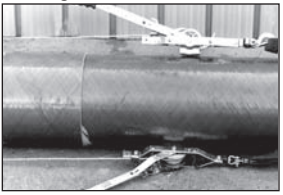
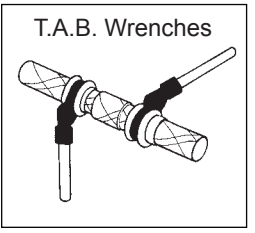


TABLE 10. Hydraulic Come-Along Pressures

Pipe Grade	Pipe Size	Hydraulic Pressure
	(In.)	(psig)
RT, GT, SS	8-10 12-16	1500-1750 1750-2000
RT PP, GT PP	8-10 12-16 18-24	1500-2000 2000-2500 3000

D. **T.A.B. Joint**:



T.A.B. Joint installation procedures follow the normal bell and spigot operations of cleaning, adhesive mixing, etc. as described above. Two T.A.B. wrenches are required when joining T.A.B. pipe. Separate wrenches are available for each size pipe. The wrenches lock around the pipe and force the pipe into a very slight oval shape. Therefore, the wrenches must be 6" to 12" away from the joint to assure good joint make up.

1. Cover all machined areas on the spigot and at least one-half inch beyond the last thread in the bell with the proper adhesive.
2. Screw the pipe together until firm using T.A.B. joint wrenches. DO NOT OVERTIGHTEN.

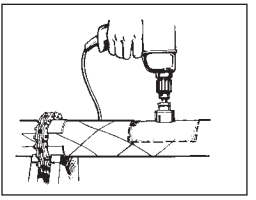
Connections into fittings are made using the normal bell and spigot methods. A threaded spigot can be bonded into a smooth bell (fitting), or a smooth spigot can be bonded into a threaded bell.

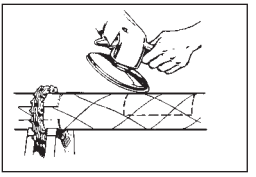
E. Saddles and Reductions

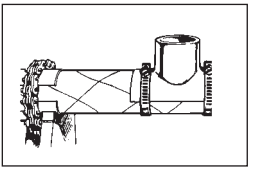
Note: ZC-275 or 3033 Adhesive is recommended for saddles.

Position the saddle on the pipe and mark around the saddle base. Use a file, a sander, or rough sandpaper (16 to 40 grit) to remove all surface gloss from the pipe O.D. where the saddle is to be bonded. (For large diameter pipe, a disc sander is usually more practical.) Use circular or random pattern motion during sanding to eliminate grooves on the pipe surface. After sanding, position the saddle on the pipe and mark the hole to be cut in the pipe. Cut a hole the same size as the saddle outlet using a pilot drill and circular hole saw or sabre saw. Do not force the cutter or it will fray the edges of the hole excessively. Clean all bonding surfaces as required. Note: Be sure cleaner (if used) has evaporated before applying adhesive to the bonding surfaces. Apply a **heavy** coat of adhesive to the O.D. of the pipe, I.D. of the saddle, and the edges of the pipe wall exposed by the hole. Place the saddle over the hole and clamp with two hose clamps or a banding tool. (Note: Banding tool must be a type that does not leave slack in the bands when the tool is removed. Use metal banding.) Using a large

screw driver, hand tighten the hose clamps alternately until secure and adhesive squeezes out all the way around the saddle. This will ensure that the pipe O.D. conforms to the saddle I.D. You can remove the clamps or leave them in place after the adhesive is cured. **Allow adhesive to cure before bonding in the side run.** Use two banding tools to pull the sides of the saddle down alternately. If two tools are not available, tighten the first band **snug**, the second band **tight**, and add a third band, pulled **tight**, on the first side. Three-quarter inch banding is recommended. If the saddles are used on non-standard pipe (pipe not listed in literature), contact your representative for special instructions.







F. **Reducer Bushings**

Install reducer bushings using a block of wood and a hammer and the same procedures as for bell and spigot pipe. The wood block should be sized to allow the reducer bushing to be counter-sunk in the bell. Some reducer bushings will be counter-sunk before they are actually locked up. For maximum chemical resistance with 8" and larger Green Thread reducer bushings, coat all machined surfaces with adhesive just before assembly.

JOINT CURE

TABLE 11. Adhesive Ambient Cure Time

Adhesive Type	Temperature (°F)	Cure Time (hrs.)
2000	110	1
	90	3
	80	4
	70	9
	60	16
	50	24
8000	110	1
	90	2
	80	4
	70	6
	60	12
	55	18

NOTE: Cure time is the time before the line can be tested. Times may vary depending upon temperature, humidity, etc.

A. Ambient Cure

Cure time is the time required for the adhesive in the assembled joint to harden. Cure time depends on the type of adhesive and the ambient temperature, as shown in Table 11.

You can shorten cure time by applying heat. Although all of the adhesives will cure at ambient temperatures above 70°F, it is recommended they be heat-cured at temperatures of at least 275°F to maximize physical properties and corrosion resistance. See page 43 for instructions for using heat collars for heat-curing joints.

B. High Temperature Heat Collar

Refer to Bulletin No. F6640 for complete operating instructions.

NOTE: 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.
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", 1½" 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 16" flange joints, use a heating collar that is one pipe size smaller. 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.

TABLE 12. Adhesive Cure Times for Electric Heating Collars

Pipe System & Adhesive Grade	Pipe Size (In.)	Cure Time (Minutes)			
		Pipe (1)	Fitting	Flange (2)	Perf. Plus
Red Thread II Green Thread Silver Streak 2000 or 8000 Series Adhesive	1 - 6	12	20	15	N/A
	8	20	20	20	30
	10	27	27	27	35
	12	30	30	30	40
	14	34	34	34	45
	16	38	38	38	60
	18-24 (3,4)	90	90	90	120
	30-36 (3)(5)	120	120	90	NA
GT 175/250 3033 Adhesive	1-6	30	30	30	NA
	8-12	60	60	60	NA
GT 175/250 8000 Adhesive	14-16	60	60	60	NA
	18-24	90	90	90	NA

NOTE: These cure times are for environments warmer than 70°F. If cooler, see "Cold Weather Installation Tips" on page 14 or consult NOV Fiber Glass Systems. Adhesives will cure in 24 hours at ambient temperatures of 70-100°F.

(1) Includes sleeve couplings.

(2) 1", 11/2" & 2" flanges require the use of an industrail heat gun. Air temperatures inside the flange should be no greater than 400°F and no less than 250°F.

(3) 18"-36" collars are un-insulated.

(4) Below 50°F, the heating collars should be wrapped in insulation to reduce heat loss.

(5) 36" heat collars require special 20 amp connectors.

C. Heat Packs

Heat packs that cure joints in approximately one hour are also available. Refer to Bulletin No. D4500 for complete instructions that are included with each kit. Observe all safety precautions listed on the instruction sheets that accompany the heat packs.

Caution: The adhesive bead will cure faster than the adhesive in the joint. It is important that the joint not be pressurized until it has been subjected to the proper time-temperature cycle. A temperature versus time to pressure curve is indicated in the instructions packaged with each adhesive kit.

REPAIRS for RED THREAD, GREEN THREAD & SILVER STREAK PIPING SYSTEMS

Fiberglass piping systems are relatively simple to repair. Normally, repair means cutting out a fitting or a damaged section of pipe and replacing it with new material.

Caution: Always determine exactly what fluid has been in the piping system. Contact may be harmful to humans. Take necessary precautions.

Always use the same pipe grade, fittings, and adhesive on new parts as is in the existing system. Do not mix pipe grades.

Inspecting for Potential Causes of Joint Failure

Joint Backout – If the bead is no longer next to the edge of the bell, the joint backed out before the adhesive cured.

Cocked Joint – If a joint is cocked or misaligned, there will usually be a large gap between the bell and spigot on one side.

Improperly Cured Joint – If the adhesive bead is soft or flexible, the adhesive is not sufficiently cured.

Weathered Joint – If the machined area appears yellow, the joint may have been exposed to UV degradation.

All damaged or improperly assembled joints must be repaired or replaced as indicated below.

REPAIRING WEATHER DAMAGE

If machined surfaces of pipe or fittings are exposed to direct sunlight prior to installation, a loss of joint bonding strength may occur. If ultraviolet exposure is greater than two hours, the following steps must be taken:

1. For exposed spigot ends, use 60 to 80 grit sand paper or Emery cloth and lightly sand to remove UV degradation. Avoid oversanding as this may alter the taper angle of the spigot and may result in voids in the bond line. If UV degradation is too severe, cut 1” from the end of the pipe and retaper.

2. For exposed bell ends (pipe or fittings), sand thoroughly until the entire surface appears fresh. Hand sanding with 40 grit sandpaper is recommended. Use a light sanding operation to prevent changing the taper angle.

NOTE: COUPLINGS OR INTEGRAL BELLS WITH T.A.B. THREADS THAT HAVE BEEN OVEREXPOSED MUST BE REPLACED.

REPAIRING MINOR DAMAGE

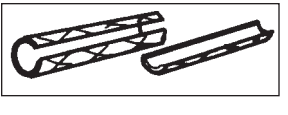
For damaged areas less than one inch in diameter in light chemical or water service.

A. Flanged Systems: If possible, simply replace the entire flanged length. Otherwise, cut out the damaged section, then 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.

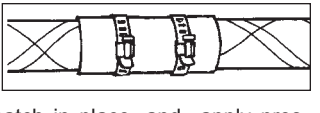
Flanged fittings should be removed from the system when damaged and replaced with a new fitting.

B. Tapered Systems: Make a patch to cover damaged area.

1. Cut a length of good pipe to adequately cover the damaged area and extend 3"-4" on either side of the damaged area.
2. Slit this "patch" lengthwise twice and remove a section so that about three-fourths of the circumference remains for 1"-4" pipe and one-half the circumference for 6" and larger pipe.



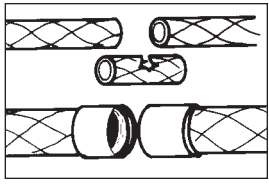
3. Thoroughly sand the inner surface of the patch and sand a corresponding area on the pipe around the damaged section.
4. Clean the bonding surfaces, then apply a thick coating of adhesive to both surfaces, snap the patch in place, and apply pressure with hose clamps. The clamps may be left on or removed after curing.



REPAIRING EXTENSIVE DAMAGE

When the damaged area in the pipe wall is larger than one inch in diameter, or for repair of pipe in severe chemical service that requires a lined product, follow these instructions:

1. When damage is local (less than one inch long, but more than two inches around the circumference of the pipe), check to see if there is enough slack in the pipe to cut out the damaged section, re-taper the cut ends, and bond a sleeve coupling between the tapered ends.



2. When damage is extensive (too large for replacement by a single sleeve coupling), cut out the damaged section, taper the cut ends, and install two sleeve couplings and a pipe nipple. **This procedure requires sufficient slack in the line to make the final joint by lifting the pipe (or moving the pipe to one side) to engage the bell and spigot joint.**
3. If the line cannot be moved sufficiently to install a sleeve coupling or a sleeve coupling spool piece, taper both ends of the pipe and install flanges.
4. If it is impossible to taper the pipe in the ditch, you can install a new section of pipe by overwrapping the plain cut ends.
   a. Clean an area large enough for installers to work on both sides and under the pipe. Cut out the damaged section of pipe and measure the gap. Cut a section of good pipe that is not more than one-half inch shorter than the length to be replaced ($1/4$" maximum gap on each end).
   b. Sand the ends of the pipe to remove all resin gloss. Align the replacement pipe section with the pipeline and block up all sections to maintain alignment. All sections must be rigid so they will not move during the overwrapping procedure. Tack welds should be used by placing 1" x 2" patches of glass cloth and adhesive (four patches spaced at 90° intervals around the pipe). See *Overwrapping on p. 48.*

REPAIRING LEAKING JOINTS

Overwrapping – If a joint leaks because of improper installation, you can repair it by overwrapping with glass cloth and resin. The temperature in the work area should be 75°F-90°F. Be sure to protect the overwrap from the sun.

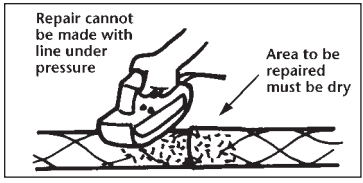
1. Use 7-10 oz. glass cloth. Components for the epoxy overwrap are available in the 8088 repair kit (see Table 13).

TABLE 13. WELDFAST 8088-S Overwrap Repair Kits

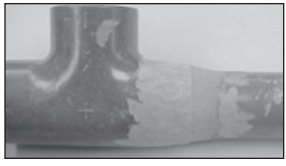
Pipe Size (In.)	Layers of Glass	Glass Width (In.)	Number of kits Required per Joint
1	4	8	0.25
1 1/2	4	8	0.25
2	6	8	0.75
3	6	8	0.75
4	6	8	1.00
6	6	8	1.50
8	8	8	2.50
10	10	8	3.50
12	12	8	5.00
14	14	8	6.50
16	16	8	8.00

NOTE: An 8088L (Large) repair kit is available for 8" and larger overwraps. A 2088 overwrap kit is available for applications with temperatures at or below 200F.

2. Use a grinder or sander with coarse grit to remove gloss five inches on either side of the joint.

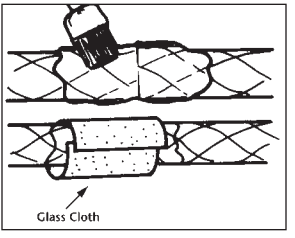


3. Bevel the shoulder to blend in with the pipe wall and add putty to make a smooth transition from fitting to pipe. The length of this putty should be held to a minimum, because the putty has limited pressure capabilities.



CAUTION: There must not be any pressure on the line or any fluid leaking from the joint when performing this procedure.

4. Re-sand and clean surfaces including bevel.
5. Thoroughly mix the adhesive and hardener with the stir stick until there is a uniform color and a consistent flow off the stir stick.
6. Using a paint brush, apply the mixed adhesive to all sanded areas.
7. Each piece of glass cloth must be slightly longer than the previous piece, because the O.D. of the pipe becomes larger as you add glass cloth. Cut the first piece to allow for two inches of overlap. When this length is no longer sufficient to overlap at least one-half inch on the ends, determine a new length with two inches of overlap.

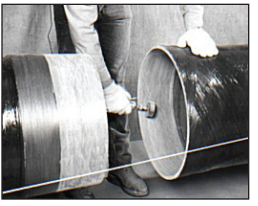


8. Center a piece of glass cloth over the joint. Pull on the cloth while positioning it and wet it out by painting with adhesive. Brush to remove any trapped air bubbles in the wrap. Start at one end of the cloth and work around the circumference, wetting the cloth with resin. Work the cloth away from the starting end and from the center of the cloth to the sides. The cloth must be thoroughly wetted with adhesive, but do not spend a lot of time in one area as the cloth will wet out (lose its shiny, white appearance) with time. By the time the cloth has been worked down smoothly with no air beneath it, most of it will be wetted out.
9. To prevent thick sections or humps in the overwrap, center the next piece of glass cloth on the joint starting from a new point on the circumference. Repeat Step 8 until all layers are applied.
10. Should the overwrap start to give off heat, discontinue wrapping and let the joint cure and cool with a fan. Sand the cured layers to remove the gloss before restarting the overwrap procedure.
11. Pay particular attention to the bottom of the overwrap as this is the area that may sag and is most difficult to see.
12. In temperatures above 90°F, protect the overwrap from direct sunlight.

PART V
FABRICATION OF F-CHEM PIPE AND FITTINGS

A. Matched Tapered Bell and Spigot Joint Prep

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



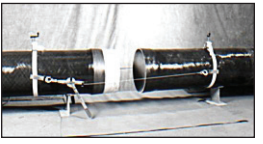
1. Prepare the bell and spigot ends of the pipe by sanding the bonding surfaces with 36 to 60 grit abrasive. The sanded area should extend at least 1/2" beyond the length of the bell.
2. Never sand more than two (2) hours before making the joint.
3. Wipe the sanded area with a clean, dry, lint-free cloth, and avoid touching the surfaces with bare hands or dirty gloves.

DO NOT USE SOLVENTS.

Note: F-CHEM fittings are available with flanged or plain ends only. See Manual No. F6080, *Pipe Installation Handbook for Socket Joints and Butt & Wrap Joints,* for joining F-CHEM fittings and pipe with butt & wrap joints.

B. Joint Assembly

1. Coupler Instructions



Attach the bands or chains to the pipe. Have the jacks and all other material ready, prior to mixing the resin and catalyst.

Place band clamps or chains approximately 3 to 4 feet from the joint on both the bell and the spigot pieces. Slip the "D" rings into place on the horizontal center line, on both sides of the pipe, prior to attaching the coupler hooks.

Unreel the couplers and hook the jacks into place. The cables may be left unattached to allow working room for the application of the adhesive.

2. Mixing Weldfast CL-100 Adhesive

a. Mix the can of Part "A" resin to fully disperse any liquid which may have separated during storage. It should be a light purple color.
b. Add the recommended tubes of Part "B" catalyst to the Part "A" resin can.
c. Mix thoroughly for a minimum of two minutes or until the color is a consistent light green.

3. Pot Life

Pot life (working time) may vary with changes in temperature and humidity.

TABLE 14. CL-100 Adhesive Estimated Pot Life

Pipe Resin System	Adhesive	Pot Life @ 70°F (min.)	Pot Life @ 90°F (min.)
Vinyl Ester	CL-100	20	10

4. Applying Weldfast CL-100 and Bonding Pipe

a. Use the brush to apply generous amounts of catalyzed resin to the bell end first, then apply to the spigot end.
b. Align the joint and guide the spigot end into the bell.
c. Attach coupler hooks and jack the joint into firm engagement. Check around the joint line to be sure that it is even, which indicates proper alignment.
d. Use brush to fill in any gaps in adhesive. Leave coupler in place during initial cure (approximately one hour).

ADHESIVE DISPOSAL: Once the adhesive and catalyst 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 catalyst can be mixed, allowed to react, and disposed of as above. If extra cans of adhesive or tubes of catalyst have accumulated without the other component to mix and react, contact your regional manager. Catalyst tubes, 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.

C. Joint Cure

Cure time is the time required for the adhesive in the assembled joint to harden and depends on the ambient temperature. ***Cure Time for CL-100 Adhesive is 24 hours.*** Cure time can be decreased and joint strength increased by heating the joint from 175°F to 225°F. Heat cure is strongly recommended for piping systems carrying fluids at temperatures above 120°F.

INSTRUCTIONS FOR USING
SILICON RUBBER HEAT BLANKET

Caution: Read Operating Instructions Before Using.

- Use only with 120 volt power outlet.
- Blanket should not be used in wet conditions.
- Tears, cuts or punctures in the blanket can create a potential safety hazard.
- The thermostat must be wrapped in the blanket to prevent overheating.

1. Use only the proper size heat blanket for the pipe being joined.
2. After the adhesive fillet has hardened, wrap the blanket around the joint by first placing the thermostat end of the blanket against the joint with the thermostat facing out. Wrap the remainder of the blanket tightly around the pipe. Hold it in place during the heating process.

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

3. 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.
4. Use aluminum foil to protect heat blanket from adhesive.
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 15. 110 Volt Silicon Rubber Heat Blanket Models (For use with F-CHEM pipe)

Pipe Size	4”-8”	10”-14”	16”-20”
Model	C	D	E

TABLE 16. Silicon Rubber Heat Blanket Cure Times for Adhesive Joint Fabrication

Piping System/ Adhesive Grade	Pipe Size (In.)	B&S Joints (hrs.)
F-CHEM CL-100	4 - 14	1
	16 - 20	4

NOTE: Heat blanket cure time refers to that time when the heat source can be removed and the pipe installed and tested at recommended pressures. Heat blanket hours pertain to 70°-100°F fabrication environment. Cure times will be longer for colder temperatures. For temperatures below 70°F, see "Cold Weather Installation Tips" on page 14 or consult Technical Services. If no heat source is available, adhesives will cure at ambient temperatures of 70°-100°F in 24 hours.

REPAIR & MODIFICATION
for F-CHEM PIPING SYSTEMS

Fiberglass piping systems are relatively simple to repair. Normally, repair means cutting out a fitting or a damaged section of pipe and replacing it with new material.

Caution: Always determine exactly what fluid has been in the piping system. Contact may be harmful to humans. Take necessary precautions.

Always use the same pipe grade, fittings, and adhesive when repairing or replacing damaged sections, or modifying the system.
If you have any questions about the chemical service, pipe grade selection, or system operating conditions, call your local Distributor or NOV Fiber Glass Systems direct.

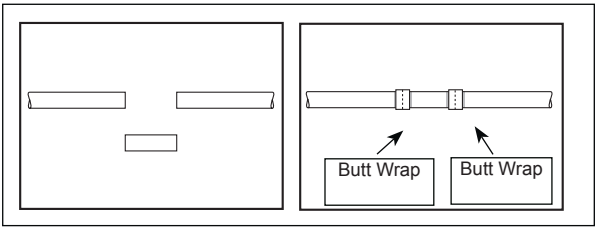
NOTE:
When making repairs, be sure all surfaces to be bonded are dry, clean and thoroughly sanded. Good adhesive connections cannot be made on wet or contaminated surfaces.

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

Flanged Systems:
If possible, simply replace the entire flanged length. Otherwise, cut out the damaged section, then 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.

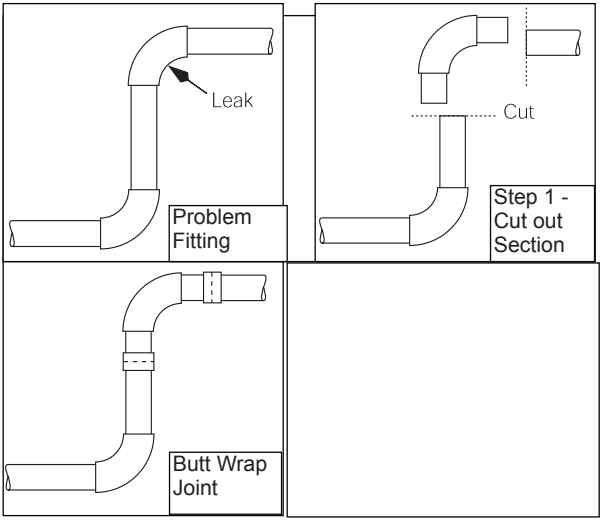
Flanged fittings should be removed from the system when damaged and replaced with a new fitting

Tapered Bell & Spigot Systems:
Cut out the section of pipe which leaks, making sure cuts are square. Dry the pipe ends. Cut a new length of pipe the same length as the piece that was cut out. Use two butt & wrap kits to bond the new pipe into place. Refer to ***Manual No. F6080 for Butt & Wrap Joint*** detailed instructions.



REPLACING DAMAGED FITTINGS
If a leak develops in an F-CHEM fitting, it will usually be necessary to cut out the leaking part and replace it. Use butt & wrap kits to bond the new fitting into place. Refer to ***Manual No. F6080*** for detailed instructions.

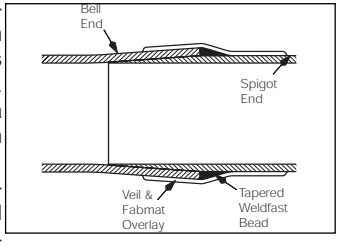
TEMPORARY FIXES, OVERWRAP



As a temporary repair, a leaking fitting, pipe or joint can be overwrapped 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 NOV 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 extend 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 bell & spigot pipe joint, use the WELDFAST adhesive putty 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 above.

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.

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 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.

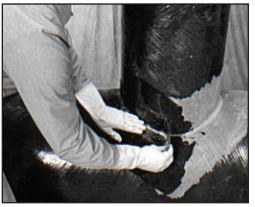
Refer to Manual No. F6080 *Butt & Wrap Joint Section* for detailed instructions.

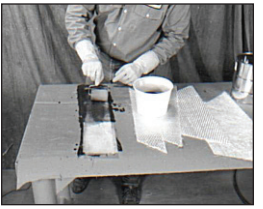
TAPPING INTO AN F-CHEM LINE

The most common method for adding a branch or tapping into an existing F-CHEM line is the use of a T-Miter. For complete instructions, see ***Bulletin Nos. D4235, D4240 or D4242***, supplied with each T-Miter kit.

Application of a T-Miter:

1. Cut the end of the new branch pipe with a contour to match the existing line pipe outside diameter.
2. Trial fit the branch pipe to the line pipe to ensure minimal gaps and mark for the hole in the line pipe.
3. Cut a hole in the line pipe the same diameter as the branch pipe inside diameter.
4. Sand both pipes with a 36-60 grit abrasive to complete roughen the bonding surface 1/2" beyond the widest layer of fiberglass to be applied.
5. Use the adhesive supplied in the kit to seal the edges of the pipe and bond the branch to the existing pipe.





6. Mix the resin supplied in the kit and wet out the sanded pipe surfaces and supplied fiberglass.
7. Apply the fiberglass to the pipe joint according to the instructions supplied in the T-Miter kit.
8. Cure the fiberglass layup.

PART VI
INSTALLATION CONSIDERATIONS

TESTING RECOMMENDATIONS

THESE PROCEDURES MUST BE FOLLOWED IN ORDER TO AVOID SERIOUS PERSONAL INJURY OR PROPERTY DAMAGE. FAILURE TO DO SO WILL RESULT IN LOSS OF WARRANTY, AND BUYER, INSTALLER, OR ANY EMPLOYEE, AGENT, OR REPRESENTATIVE THEREOF, ASSUMES THE RISK OF ANY DAMAGE OR INJURY TO PERSON OR PROPERTY.

NOTE: Follow all applicable local codes and prudent engineering practices.

HYDROSTATIC TESTING

Wherever possible, the piping system should be hydrostatically tested prior to being put into service. Care should be taken when testing, as in actual installation, to avoid water hammer. Locate all test equipment away from the end of the piping system.

Above Ground: All anchors, guides and supports must be in place prior to testing.

Buried Systems: Before testing, make sure the piping system is secure in the ditch with complete bedding under the pipe and enough backfill material in the middle of the pipe to hold the pipe in place. Joints should be left open for visual inspection during test.

To hydrostatically test the line, observe the following: 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 the high points. Slowly close the valve, and bring the system gradually up to the desired pressure.

A. Test Procedures (RT, GT, SS)

The normal recommended procedure is to conduct a cyclic pressure test. The piping system is subjected to 10 pressurization cycles at 1½ times the anticipated or design operating pressure. Pressure is then kept on the system for 1-8 hours while the line is inspected for leaks. When higher test pressures are desired, the test pressure should not exceed 1½ times the maximum rated **cyclic** pressure for the lowest rated component in the system. For low pressure

applications, such as drain lines, the cyclic test may be replaced by a steady pressure test. Lines that can be subjected to severe temperature cycles, such as steam condensate lines, hot water lines, and cold water lines, should be tested using the cyclic test procedure at 1½ times the cyclic pressure rating, even if the system is to operate at relatively low pressure. Vacuum or external pressure testing must not exceed the external pressure rating.

B. Test Procedures (F-CHEM)

Test pressure should not be more than 1-½ times the working pressure of the piping system, and never exceed 1-½ times the rated operating pressure of the lowest rated component in the system. When testing is completed, open all of the air bleeds before draining the piping. This will prevent vacuum collapse of the pipe.

WARNINGS:

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, NOV Fiber Glass Systems 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.

Pipe Diameter											
	1”	**1½”**	**2”**	**3”**	**4”**	**6”**	**8”**	**10”**	**12”**	**14”**	**16”**
psig	**25**	**25**	**25**	**25**	**25**	**25**	**14**	**9**	**6**	**5**	**4**

For larger diameters, contact NOV Fiber Glass Systems.

C. Test Frequency

It is strongly suggested that pressure tests be performed on small sections of the installation as they are completed to assure that the installation techniques are satisfactory.

•READ THIS CAREFULLY•

D. SAFETY PRECAUTIONS

As in any system where pressure is employed, adequate safety precautions should be exercised.

Locate pressure gauges in close proximity to the pressurizing equipment, not directly on the piping system. Stay away from the ends of the pipeline. Do not straddle pipe. Use of a pressure gauge, with the test pressure at mid-scale, is recommended.

In buried applications, it is suggested that long pipe runs be partially backfilled at various points to secure them in place. All joints and connections should be left exposed for inspection.

In exposed pipe systems, standard pipe guides and hangers will normally be sufficient to restrain the pipe during testing.

SYSTEM STARTUP

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 NOV Fiber Glass Systems' 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 failed fittings due to pipe system movement caused by pressure. Insufficient system anchors, guides and supports allow excessive movement of the piping and creates fitting failures.

Installing slow operating valves, a pump bypass or surge protectors in the system is recommended.

Air in a system can also cause water hammer. Be sure to bleed air out of the piping prior to full pressure operation. Any pipe system which moves suddenly, creates a lot of noise, or is unstable is susceptible to water hammer.

FIBERGLASS FLANGES

Before bonding the flange onto the pipe, make sure the bolt holes line up with the mating bolt holes on the other system. Do not bolt the flange before bonding, unless insertion depth of the spigot is previously checked to be certain that the spigot does not bottom out or extend through the flange. The use of flat washers on all nuts and bolts is required. The maximum allowable torque is indicated on each flange and is also shown in Tables 18, 20 and 21.

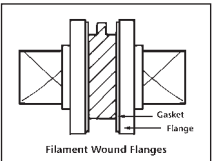
Flanges are designed to meet ANSI B16.5, Class 150 bolt hole standards. Full-face gasketing materials, 1/8" thick, with a Shore A hardness of 60 to 70 durometer, are recommended for fiberglass flanges. Gaskets made from Teflon® and PVC usually have high durometer ratings and are not acceptable.

Connecting to Flat-Face Flanges:
Fiberglass flanges may be joined to flat-face flanges at the recommended torque levels when using proper gasketing material.

Connecting to Raised-Face Steel Flanges:
When connecting to a raised-face steel flange, one of the following must be utilized:

a. Use filament wound fiberglass flanges,

b. Use molded fiberglass flanges and machine the steel flange face until it is flat or use a metal spacer ring to fill the void between the raised-face steel flange and the fiberglass flat-face flange (normally more difficult than machining the steel flange face). If metal spacer rings are not available, it is acceptable to use spacer rings made from materials that are at least as hard as the fiberglass flange.



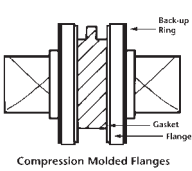
Filament Wound Flanges
FIGURE 8.3

c. Use metal back-up rings behind molded fiberglass flanges (See Figs. 8.4 and 8.5).

Connecting to Lug or Wafer Valves:
Most lined valves need a flat surface to seal against and a sealing surface that is close to their own I.D. to properly seat the lining. Unlined valves with sealing components in the face are in the same category as lined valves. Sometimes the sealing ridges on the valve face can fall in the wrong place for the grooves in fiberglass flange faces, or they can be too close to

the I.D. to seal. When connecting to valves with other than flat-faced flanges, follow these recommendations:

1) For unlined lug and wafer valves without integral seals, use filament wound flanges with no back-up rings or molded flanges with metal back-up rings. (See Fig. 8.3, 8.4, and 8.5)



Compression Molded Flanges

FIGURE 8.4

Back-up Ring Thickness	
Pipe Size	Ring Thickness
1" - 8"	1/2"
10" - 12"	3/4"

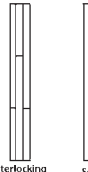


FIGURE 8.5

2) For lug and wafer valves that are lined or have integral seals, use a ¼" steel spacer plate with an I.D. equal to Schedule 40 steel or as required by the valve manufacturer. (See Fig. 8.6)

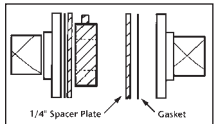


FIGURE 8.6

SUMMARY

• **Molded flanges** are designed to be used against flat-face flanges. When joining to raised-face flanges and lug or wafer valves, steel back-up rings should be used, or spacers fabricated from any material capable of preventing the flange face from bending.

• **Filament wound flanges** may be mated to raised-face flanges and lug or wafer valves with no back-up rings or spacers if the bolt torque limits shown in Tables 18, 20 and 21 are not exceeded.

• When using lug and wafer valves with integral seals, it may be necessary to use a ¼" thick steel flange between the valve and the fiberglass flange to achieve a proper seal. A ⅛" thick full-face gasket should be used between the steel flange face and the fiberglass flange.

• When using **smooth-face flanges** (non-standard) for pressures above 25 psig, it is necessary to glue a 0.20" to a 0.35" diameter, 80 durometer O-ring to the full-face gasket. A composite retainer O-ring gasket may also be used to seal smooth-face flanges.

STANDARD BOLTING CONDITIONS

NOV Fiber Glass Systems' flanges are designed to meet ANSI B16.5 Class 150 bolt hole standards. **For RT, GT & SS,** full-face gasketing materials, 1/8" 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 17.

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

TABLE 17. Gasket & O-Ring Requirements for F-CHEM Stub Flanges & Flanged Fittings

Pipe Size (In.)	Pressure Rating (psig)	Gasket[1] I.D. (In.)	Gasket[1] O.D. (In.)	O-Ring[2] Cross Section	O-Ring[2] I.D.
14	50-100 125-150	14 3/16 -	21 -	- .275	- 15.475
16	50-100 125	16 3/16 -	23½ -	- .275	- 17.455
18	50-100 125	18 3/16 -	25 -	- .275	- 19.455
20	50-75 100	20 3/16 -	27½ -	- .275	- 21.629
24	50-75 100	24 3/16 -	32 -	- .275	- 26.129
30	50-75 100	30 3/16 -	38¾ -	- .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 -	59½ -	- .500	- 50.680
54	50-75	-	-	.500	56.770
60	50-75	-	-	.750	62.590
72	50-75	-	-	.750	75.340

[1]Use ANSI 16.5 Class 150 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.

TABLE 18. Bolt, Washer & Torque Requirements for RT, GT, SS Flanges & Flanged Fittings[1]

Flange Size (In.)	Number of Bolts[3]	Machine Bolt[2] Size	Stud Bolt[2] Size	Maximum Allowable Torque in Ft. Lbs.
1	4	½ - 13x3	½ - 13x4	25
1 ½	4	½ - 13x3	½ - 13x4	25
2	4	⅝ - 11x3	⅝ - 11x4	30[4]
3	4	⅝ - 11x4½	⅝ - 11x5½	30[4]
4	8	⅝ - 11x4½	⅝ - 11x5½	30[4]
6	8	¾ - 10x5½	¾ - 10x6	30[4]
8	8	¾ - 10x5½	¾ - 10x6½	100
10	12	⅞ - 9x6	⅞ - 9x7½	100
12	12	⅞ - 9x6 ½	⅞ - 9x7½	100
14	12	1 - 8x7	1 - 8x8	100
16	16	1 - 8x7	1 - 8x8	100
18	16	1⅛ - 7x7½	1⅛ - 7x8¾	100
20	20	1⅛ - 7x7½	1⅛ - 7x8¾	100
24	20	1¼ - 7x7¾	1¼ - 7x9½	100

(1) Most flanged fittings are available with molded flanges. Filament wound flanges are available on request.

(2) Bolt lengths are nominal. When joining our flanges to flanges of other material or manufacturers products, bolt length must be calculated.

(3) 1"-24" flanges are ANSI B16.5 Class 150 lb. bolt hole standard.

(4) HD filament wound flanges are available in 2"-6" sizes with a maximum allowed torque of 100 ft. lbs.

NOTE: Washers are required with all nuts and bolts.

ANSI B-18.22.1, Type A (plain narrow series) are recommended for all Centricast flanges.

Recommended Bolt Torquing Sequence for NOV Fiber Glass Systems' Flanges

Before bonding the flange onto the pipe, make sure the bolt holes line up with the mating bolt holes on the other system. Do not bolt the flange before bonding unless insertion depth of the spigot is previously checked to be certain that the spigot does not bottom out or extend through the flange.

TABLE 19. Recessed Bolt Hole Data for RT, GT, SS(1)

Flange Size (In.)	Stud Size (In.)	Recess Depth (In.)	Washer O.D. (In.)	No. of Studs
3	5/8	1/4	1 5/16	4
8	3/4	1/2	1 1/2	4
10	7/8	5/8	1 3/4	4
12	7/8	3/4	1 3/4	4
14	1	1/2	2	4
16	1	1/2	2	4

TABLE 20. Bolt, Washer & Torque Requirements for RTPP and GTPP Van Stone-Type Flanges(2)

Flange Size (in.)	No. of Bolts	Machine Bolt (3) Size	Stud Bolt Size	Maximum Allowable Torque in Ft. Lbs. RTPP, GTPP
8	12	7/8-9x11	7/8-9x12	200
10	16	1-8x12	1-8x13	200
12	16	1 1/8-7x13 1/2	1 1/8-7x15	200
14	20	1 1/8-7x15	1 1/8-7x16 1/2	200
16	20	1 1/4-7x17 1/2	1 1/4-7x19	200
18	24	1 1/4-7x20 1/2	1 1/4-7x22	200
20	24	1 1/2-6x23	1 1/2-6x25	200
24	24	1 1/2-6x27	1 1/2-6x28 1/2	200

(1) On 3", 14" and 16" 45° flanged elbows and on all 8", 10" and 12" flanged fittings, four holes are recessed for clearance during assembly. Studs are recommended for assembly. Stud length is dependent on adjacent flange.
(2) Flanges are ANSI B16.5 Class 300-lb. bolt hole standard.
(3) Bolt lengths are nominal. When joining our flanges to flanges of other material or manufactures, bolt length must be calculated.

Note: Washers are required with all nuts and bolts.

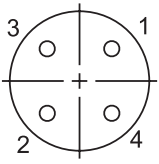
TABLE 21. Bolt, Washer & Torque Requirements for F-CHEM Flanges & Flanged Fittings

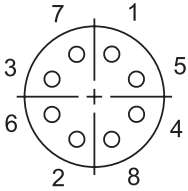
Pipe Size (in.)	Pressure Rating (psig)	No. of Bolt Holes	Machine Bolt Size	Stud Bolt Size	Bolt Torque (ft.lbs.)	
					(Nom)	(Max)
14	50	12	1-8x4 1/2	1-8x6	75	100
	75	12	1-8x5	1-8x6	85	110
	100	12	1-8x5	1-8x7	90	120
	125	12	1-8x5 1/2	1-8x7	50	100
	150	12	1-8x6	1-8x7	50	100
16	50	16	1-8x4 1/2	1-8x6	75	100
	75	16	1-8x5	1-8x6	85	110
	100	16	1-8x5 1/2	1-8x7	90	120
	125	16	1-8x6	1-8x7	50	100
18	50	16	1 1/8-7x5	1 1/8-7x6	75	100
	75	16	1 1/8-7x5 1/2	1 1/8-7x7	85	110
	100	16	1 1/8-7x6	1 1/8-7x7	90	120
	125	16	1 1/8-7x6 1/2	1 1/8-7x8	50	100
20	50	20	1 1/8-7x5	1 1/8-7x7	90	120
	75	20	1 1/8-7x5 1/2	1 1/8-7x7	105	140
	100	20	1 1/8-7x6	1 1/8-7x8	75	125
24	50	20	1 1/4-7x5 1/2	1 1/4-7x7	90	120
	75	20	1 1/4-7x6	1 1/4-7x8	105	140
	100	20	1 1/4-7x6 1/2	1 1/4-7x8	75	125
30	50	28	1 1/4-7x6	1 1/4-7x8	105	140
	75	28	1 1/4-7x6 1/2	1 1/4-7x8	120	160
	100	28	1 1/4-7x7	1 1/4-7x9	75	125
36	50	32	1 1/2-6x6 1/2	1 1/2-6x9	105	140
	75	32	1 1/2-6x7 1/2	1 1/2-6x9	120	160
	100	32	1 1/2-6x8	1 1/2-6x10	100	150
42	50	36	1 1/2-6x7	1 1/2-6x9	120	160
	75	36	1 1/2-6x8	1 1/2-6x10	100	150
	100	36	1 1/2-6x8 1/2	1 1/2-6x10	100	150
48	50	44	1 1/2-6x7 1/2	1 1/2-6x9	120	160
	75	44	1 1/2-6x8	1 1/2-6x10	100	150
	100	44	1 1/2-6x9	1 1/2-6x11	100	150
54	50	44	1 3/4-5x8	1 3/4-5x10	100	175
	75	44	1 3/4-5x9	1 3/4-5x11	100	175
60	50	52	1 3/4-5x8 1/2	1 3/4-5x11	100	175
	75	52	1 3/4-5x9 1/2	1 3/4-5x12	100	175
72	50	60	1 3/4-5x9 1/2	1 3/4-5x11	125	200
	75	60	1 3/4-5x11	1 3/4-5x13	125	200

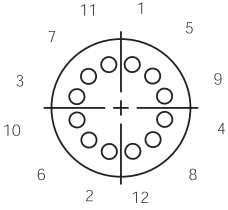
(1) Use two washers with each bolt. Use SAE standard washers under all nuts and bolt heads up to 48" size. Use USS wrought washers for 54" and larger sizes.

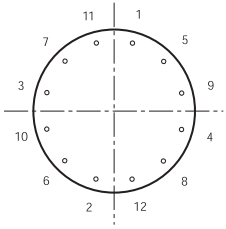
(2) Bolt lengths are nominal. When joining flanges to flanges of other material or manufacturer, bolt length must be calculated. Note: Special bolt lengths are required for blind flanges.

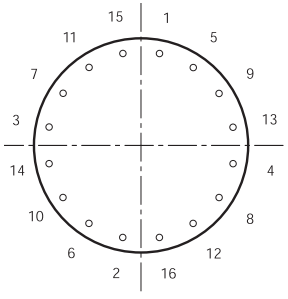
Recommended Bolt Torquing Sequence for Flanges

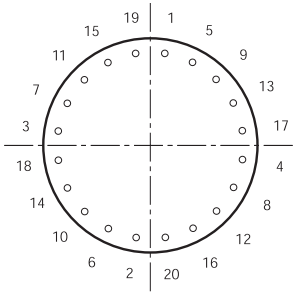


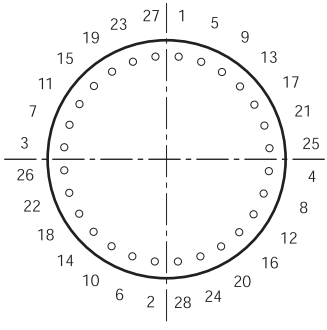


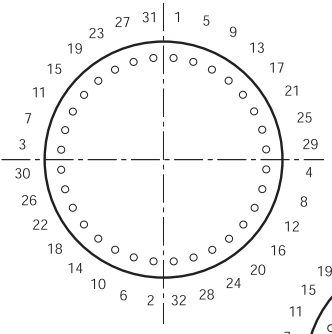








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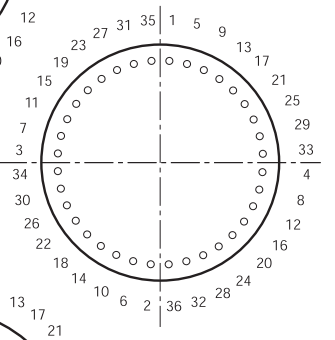
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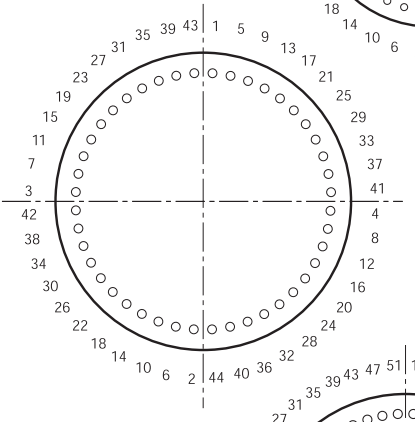
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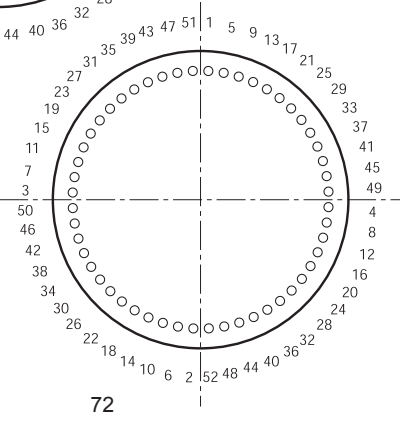
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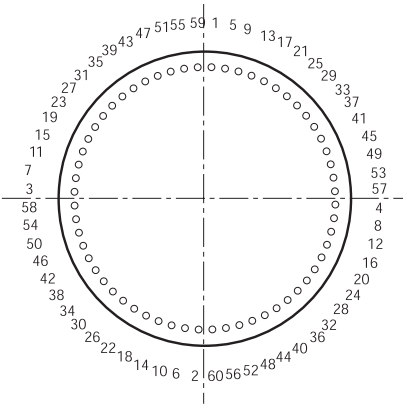


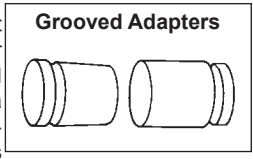
CONNECTING TO OTHER SYSTEMS

It is often necessary to connect a fiberglass piping to another piping system or make a connection that will not be possible using flanges. Two types of adapters are available: bell or spigot by grooved ends and bell or spigot by threaded ends.

ADAPTERS

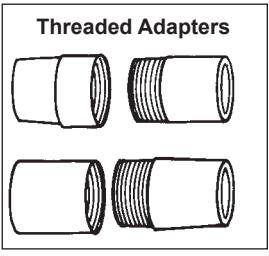
Note: When using adapters with spigot ends, it may be necessary to cut off a portion of the factory pipe bell if the groove or threads are not fully exposed.

A. Grooved Adapters



RT, GT, SS Product: Do not use couplings designed for plastic or cement-lined steel as they can leak due to a difference in groove dimensions. Grooved adapters are machined to ES dimensions. Use standard high pressure (Victaulic Style 77) coupling or equivalent.

B. Threaded Adapters

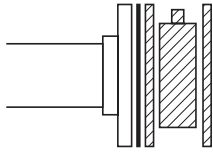


When using threaded adapters, thread them into the other system before bonding onto our pipe. Otherwise, unless a union is used, it may be impossible to turn the adapter into the mating thread. Use soft set, nonmetallic thread lubricant or two wraps of Teflon tape. Caution: Do not overtighten. Tighten the adapters as if they were brass or other soft material.

NOTES:

1. The use of NOV Fiber Glass Systems' adhesive to bond a steel or metal pipe into a fiberglass flange is not recommended.
2. If mating a fiberglass system to steel, the preferred method is with flanges. Terminate the old system with their 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 fiberglass system.
4. Do not try to thread pipe or fittings.

SPECIAL BOLTING CONDITIONS



It is often necessary to mate fiberglass flanges with other components which do not have a full flat-face surface such as raised face flanges, butterfly or check valves having 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 fiberglass flange.

Pump & Equipment Connection

Fiberglass 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.

PAINTING PIPE

All piping O.D. surfaces should be clean and dry before painting. Use a fast-drying solvent such as acetone or trichloroethylene to clean the O.D. of RT, GT, or SS. For longer lasting results, and for F-Chem pipe, the O.D. should be thoroughly sanded or sand blasted. If sand blasting, be careful not to cut or groove the pipe O.D. with an aggressive spray. Our pipe can be painted with any good quality epoxy ester or two-part epoxy paint. Contact your local paint supplier for a detailed recommendation.

PART VII
HELPFUL INFORMATION
CONVERSIONS

	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 sq. 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 FRACTIONS

Inches	Decimal of an Inch	Inches	Decimal of an Inch
1/64	.015625	29/64	.453125
1/32	.03125	15/32	.46875
3/64	.046875	31/64	.484375
1/20	.05	1/2	.5
1/16	.0625	33/64	.515625
1/13	.0769	17/32	.53125
5/64	.078125	35/64	.546875
1/12	.0833	9/16	.5625
1/11	.0909	37/64	.578125
3/32	.09375	19/32	.59375
1/10	.10	39/64	.609375
7/64	.109375	5/8	.625
1/9	.111	41/64	.640625
1/8	.125	21/32	.65625
9/64	.140625	43/64	.671875
1/7	.1429	11/16	.6875
5/32	.15625	45/64	.703125
1/6	.1667	23/32	.71875
11/64	.171875	47/64	.734375
3/16	.1875	3/4	.75
1/5	.2	49/64	.765625
13/64	.203125	25/32	.78125
7/32	.21875	51/64	.796875
15/64	.234375	13/16	.8125
1/4	.25	53/64	.828125
17/64	.265625	27/32	.84375
9/32	.28125	55/64	.859375
19/64	.296875	7/8	.875
5/16	.3125	57/64	.890625
21/64	.328125	29/32	.90625
1/3	.333	59/64	.921875
11/32	.34375	15/16	.9375
23/64	.359375	61/64	.953125
3/8	.375	31/32	.96875
25/64	.390625	63/64	.984375
13/32	.40625	1	1.0
7/16	.4375		

DEFINITION OF TERMS

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.

ANCHORS – Device to positively restrain the movement of the pipe against all lateral and axial forces.

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.

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 centerline.

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 thermoset resin system by the action of heat or chemical action.

CURE STAGES – Stages describe the degree to which a thermoset resin has crosslinked. Three stages, in order of increasing cross linking, include B-stage, gelled, fully cured.

CURE TIME – The time required for a thermoset 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 – Fittings manufactured by cutting, assembling and bonding pipe sections into a desired configuration. The assembled product is then overwrapped with resin-impregnated roving or glass cloth, to provide added strength.

EPOXY RESIN – A thermosetting resin, usually made from Bisphenol A and epichlorhydrin, cured by a variety of agents such as anhydrides and amines. These resins contain cyclic ether groups. See thermoset.

FRP – Fiberglass Reinforced Plastic.

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.

GUIDE – Device that allows free axial movement of the pipe, but restrains lateral movement.

HAND LAY-UP – The forming of resin and fiberglass into finished pipe products or fittings by manual procedures. These procedures include overwrap 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.

LOCK-UP –A bell and spigot joint engaged sufficiently to eliminate pivot action in the joint.

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.

MECHANICAL FORCE – Physical exertion of power used to achieve lock-up in tapered bell and spigot joints.

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.

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 Bisphenol 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 thermoset adhesives after the reactive materials have been mixed.

PRESSURE RATING – The maximum anticipated long term operating pressure a manufacturer recommends for a given product. Also referred to as working pressure, pressure class or design pressure.

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-in.) lengths.

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

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-in.) 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.

SPACERS – Wooden strips used to support pipe during storage and handling.

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, which can induce stress.

SUPPORT SPACING (span) – The recommended maximum distance between pipe supports to prevent excessive pipe deformation (bending).

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 (pipe) transmits heat from an area of high temperature to an area of lower temperature. Fiberglass pipe has low thermal conductivity.

THERMAL EXPANSION – The increase in dimensions of a material (pipe) resulting from an increase in temperature. A decrease in temperature results in thermal contraction.

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

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

THRUST FORCES – Commonly used to describe the 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 hydraulic pressure.

TORQUE – Used to quantify a twisting moment (torsion) in 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.

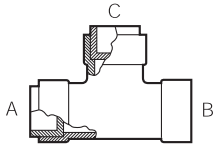
VINYL ESTER – A premium resin system with excellent corrosion resistance. Vinyl ester exhibits high versatility, temperature resistance and excellent corrosion resistance to acids.

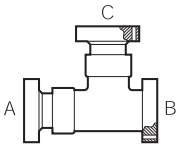
WATER HAMMER – Pressure surges in a piping system caused by sudden change in fluid velocity, such as operation of a valve, pump, or other component.

WORKING LIFE – Same as POT LIFE.

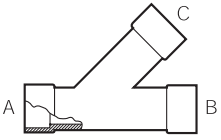
HOW TO READ FLANGED OR REDUCING FITTINGS

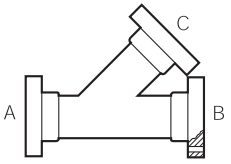
TEE



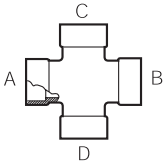


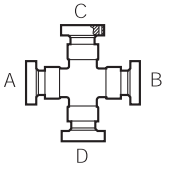
Run x Run x Branch





LATERAL
Run x Run x Branch

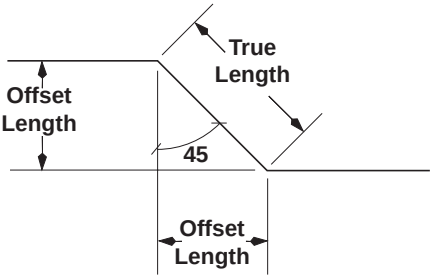




CROSS
Run x Run x Branch X Branch

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")

ISO 9001

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