



# STAR™ Threaded Line Pipe

Pipe Installation Handbook

8rd (ACT, PGT)

O-Ring (SS, SSSHP, CEN, SP, SPH)

---

**Fiber Glass Systems**

**NOV** Completion &  
Production Solutions

[nov.com/fgs](http://nov.com/fgs)



# Introduction

1. This installation handbook is offered to assist you in the proper installation procedures of Fiber Glass Systems STAR high pressure line pipe.
2. If you have any questions regarding procedures in this installation handbook, please contact a Fiber Glass Systems Representative for assistance.
3. Fiber Glass Systems Field Service Representatives will not substitute for a crew member, nor be responsible for supervising the crew, nor does their presence warrant that the installation practices have been correctly performed.
4. It is the Customer's, Contractor's, and End-User's responsibility to read and understand all engineering and installation related handbooks, guides, and other relevant documents for the product to be installed and understand the Field Service Policy as it relates to onsite training and/or certification.
5. Fiber Glass Systems does not warrant the installation of the goods nor shall it be responsible for the performance of workmanship of any person or entity engaged in the installation or installation supervision.
6. It is strongly recommended that all installers be properly trained prior to the installation. Fiber Glass Systems offers several types of certification training classes and/or installation job startups.
7. Fiber Glass Systems recommends a pre-installation startup meeting with the Distributor, Sales Manager, and Field Service to discuss specifics of the installation to include but not limited to:
  - Review handling and storage
  - Review installation procedures
  - Tools and materials required for a proper installation
  - Job startup and/or certification training by a certified Fiber Glass Systems Representative
  - Review installation schedule

8. Fiber Glass Systems strongly recommends early hydrostatic testing to ensure the reliability of the field workmanship. Testing is recommended at the following intervals of the installation:

- STAR high pressure line pipe – first 5,000-ft maximum
- Fitting intensive piping projects – first 50 joints maximum



### **SAFETY**

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

### **CAUTION**

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

## **Fabrication and Installation Assistance**

**Prior to starting** an installation, several parameters must be defined:

- Type of service
- Service conditions such as natural gas require an additional safety factor of 0.67
- Buried or above ground installation
- Type of thread
  - API 5B 10rd or 8rd
  - Super Seal – CEN
  - Super Seal – SP
  - Super Seal – SPH
  - Super Seal – SS
  - Super Seal – SS-HP

- Type of lubricant
- Type and size of O-ring for Super Seal threads
- Required fittings, flanges, and flange accessories
- Acquire proper tools such as makeup wrenches, select thread lubricant or sealant, and accessories
- Check the effect of makeup thread length loss on the quantity of pipe ordered (Reference Table 5)

### **Responsibility of the Fiber Glass Systems Field Service Representative**

- Train and advise the supervisor and crew members in the recommended practices in this handbook.
- Provide testing after training to qualified personnel who handle pipe Any new or substitute crew member and supervisor must be trained prior to taking over activities. At minimum, two experienced and qualified crew members and a supervisor must be on location. Their qualifications must be in accordance with the procedures in this manual.

### **Procedure / Personnel Qualification**

- It is recommended that each person responsible for working on the connections be qualified and tested in accordance with recognized standards such as:
  - API 15TL4, Appendix B
  - ISO 14692, Section 4
  - ASME B31.3
  - Basic Fiber Glass Systems training

# Table of Contents

- Section 1 — STAR Line Pipe Products
- Section 2 — Installation Tools and Equipment
- Section 3 — Receipt, Handling and Inspection
- Section 4 — Line Pipe Installation
- Section 5 — STAR 10rd and 8rd Joint Assembly
- Section 6 — STAR Super Seal Joint Assembly
- Section 7 — Field Hydrostatic Testing
- Section 8 — Fiberglass to Steel Connections
- Section 9 — Field Fabrication

# Table of Contents

Introduction .....	3
Fabrication & Installation Assistance .....	4

## Section 1

### **STAR Line Pipe Products** **10**

---

Line Pipe .....	11
Resin Systems .....	11
Threaded Connections.....	12

## Section 2

### **Installation Tools and Equipment** **13**

---

## Section 3

### **Receipt, Handling and Inspection** **18**

---

Transportation .....	19
Load Inspection .....	19
Unloading.....	20
Storage .....	20
Ultraviolet Effects .....	21
Reshipping and Stringing Line Pipe .....	22

## Section 4

### **Line Pipe Installation** **23**

---

Burial Guidelines .....	24
Ditch Preparation.....	24
Backfill Guidelines .....	27
Buried Installation .....	29
Above Ground Installation.....	47

## Section 5

### **STAR 10rd and 8rd Joint Assembly** **49**

---

Introduction .....	50
Makeup Tools.....	50

Precautions.....	50
Cleaning and Inspection .....	52
Lubricant.....	52
Joining Procedures .....	53
Lowering Pipe in Trench (Roping) .....	55

## Section 6

### **STAR Super Seal Joint Assembly** **56**

---

Introduction .....	57
Makeup Tools.....	57
Precautions.....	58
Lubricant.....	60
Cleaning and Inspection .....	60
Joining Procedure .....	62

## Section 7

### **Field Hydrostatic Testing** **66**

---

Frequency .....	67
Preparation.....	67
Testing.....	67
Locating a Leak.....	68

## Section 8

### **Fiberglass to Steel Connections** **69**

---

STAR Threaded Connections.....	70
STAR Flanges.....	72

## Section 9

### **Field Fabrication** **82**

---

API 8rd Threaded Nipples .....	83
Super Seal Threaded Nipples .....	83
Repair Methods.....	85
Bell x Male Threaded Adapters .....	90
Application of STAR 8rd Field Threads.....	94



## Tables

Table 1 - Threaded Connections/Resin Systems .....	12
Table 2 - Ultraviolet Effects on GRE Pipe .....	21
Table 3 - Recommended Bedding Materials .....	28
Table 4 - Maximum Deflections (per joint) .....	33
Table 5 - Recommended Tools, Lubricants, Crew Size/Installation Rates ..	51
Table 6 - STAR Super Seal Connections .....	57
Table 7 - STAR Super Seal Makeup Tool Recommendations .....	59
Table 8 - O-ring Size Chart .....	60
Table 9 - General Guidelines for O-ring Compatibility .....	61
Table 10 - STARAPI 8rd Thread Table .....	71
Table 11 - STARAPI 8rd Thread Removal .....	71
Table 12 - Bolt Torque vs Bolt Size .....	74
Table 13 - Typical Thread Dimensions .....	75
Table 14 - Thread Size - Maximum Pressure Ratings .....	84
Table 15 - Bonded Saddle Repair .....	89
Table 16 - Bonded Bell x Male Thread Adapter Codes .....	90
Table 17 - O-ring Bell x Male Thread Adapter Codes .....	93
Table 18 - Cure Methods .....	93

## Figures

Figure 1 & 2 - Stable Soil .....	25 & 26
Figure 3 - Unstable Soil .....	26
Figure 4 & 5 - Road Crossing .....	30
Figure 5 & 6 - Thrust Block .....	31
Figure 8 - Line Crossing Burial Depth .....	46
Figure 9 - Natural Roping of Line to Flange .....	47
Figure 10 - Recommended Riser Configuration, 45° Elbow .....	47
Figure 11 - Recommended Riser Configuration, 90° Elbow .....	47
Figure 12 - Proper Aligning for Joining .....	54
Figure 13 - Flange Connection, Fiberglass to Fiberglass .....	73
Figure 14 - Flange Connection, Flat Face to Flat Face .....	73
Figure 15 - Flange Connection, Flat Face to Raised Face .....	74
Figure 16 - Flange Bolt Torque Sequence .....	81
Figure 17 & 18 - Repair Method #1 .....	86
Figure 19 - Repair Method #2 .....	88
Figure 20 - Repair Method #3 .....	88

# Section 1

## STAR Line Pipe Products

# STAR Line Pipe Products

## Line Pipe

The performance characteristics of a fiberglass piping system depend on several important elements including, but not limited to the resin system, curing agent, and manufacturing process.

STAR Line Pipe is manufactured by using the epoxy resin system along with one of three distinct curing agents: Anhydride, Aliphatic Amine or Aromatic Amine. All are heat cured for optimum chemical resistance and physical properties.

Each resin system has certain characteristics, such as mechanical properties, chemical resistance, temperature capability, and cost which may make one system more suitable than the other for a particular application.

Match your temperature, pressure, and chemical resistance requirements to the fiberglass piping system

## Resin Systems

**STAR Anhydride Line Pipe** – Ideally suited for the majority of common oilfield applications. Fluids such as sweet and sour crude, fresh water, salt water, multiphase service, natural gas, and nitrogen can be transported at continuous service temperatures of up to 150 °F (65 °C).

**STAR Aliphatic Amine Line Pipe** – Ideally suited for the majority of common oilfield applications. STAR Aliphatic Amine Line Pipe can handle all the fluids mentioned above for Anhydride and can handle continuous service temperatures of up to 200 °F (93 °C).

**STAR Aromatic Amine** – Ideally suited for the majority of oilfield applications that require high temperature service. STAR Aromatic Amine Line Pipe can handle all the fluids listed above and can handle continuous service temperatures of up to 212 °F (100 °C).

## Threaded Connections

STAR Line Pipe offers the industry standard API 5B 10rd and 8rd connections, and also offers 5 proprietary connections known as Super Seal – CEN, SP, SPH, SS, SS-HP.

Table 1 shows the threaded connections that are available for each resin system.

**Table 1**

STAR Line Pipe

Resin Systems	Connection Type	Pipe Size
STAR Anhydride	API 5B 10rd/8rd	1 ½"-8"
	CEN	2"-3"
	SP	2"-4"
	SPH	4"-6"
	SS-HP	6"-12"
STAR Aliphatic Amine	API 5B 10rd/8rd	1 ½"-8"
	SS	8"-12"
STAR Aromatic Amine	API 5B 10rd/8rd	1 ½"-8"
	CEN	2"-3"
	SP	2"-4"
	SPH	4"-6"
	SS-HP	6"-12"

# Section 2

## Tools and Equipment

Metal Friction Wrench  
Strap Wrench  
Unique Tapering Tool  
Unique Grinding Tool  
STARtec  
Hi Pro Plus  
Epoxy Kit

Pin Mold  
Woven Roving  
Heat Collar  
Pipe Roller/Cradle  
Centrilizers  
Standard Pull on End Seals

## Metal Friction Wrenches

Designed to give 360 degrees of uniform compression on the male pipe upset, STAR metal friction wrenches are used for make-up and break out of GRE pipe 8rd threaded connections. The wrenches are equipped with replaceable dies which firmly grip the pipe without slipping. The dies may require replacement if they become dull from heavy usage. These wrenches are hand operated tools; handle extensions which reduce the required force can be used successfully and are recommended for larger pipe sizes.



**Photo 1**  
Metal Friction Wrench

## Strap Wrenches

The STAR recommended strap wrenches are designed to be used by hand on GRE pipe. These wrenches should always be used on the pipe end connection upsets, never on the pipe body. Handle extensions can be used successfully on wrench sizes No. 11 and larger. These wrenches require the use of abrasive powder to assist the grip of the strap on the pipe. Never use the point of the wrench against the strap onto the pipe; always use the heel which provides uniform compression 360° around the pipe.

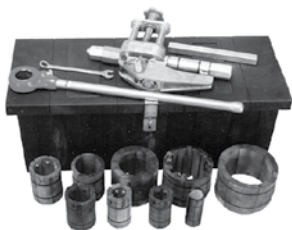


**Photo 2**  
Strap Wrench

## Unique Tapering Tool -

### Model 010 (2"-6")

The Unique Tapering Tool Model 010 series is designed to accurately cut tapers on GRE pipe in nominal pipe sizes 2" through 6". It can be operated manually by a ratchet or by an electric power drive. (Ridgid® #700). The Unique Tapering



**Photo 3**  
Tapering Tool - Model 010

Tool Model 010 series is factory assembled with 2" expandable collets, Ridgid 11-R ratchet, 3/4" end wrench, 1" nipple bar and detailed instructions in a plastic box.

### Unique Grinding Tool - Model 10-612 (2"-12")

The Unique Grinding Taper Tool - Model 10-612 is designed to accurately cut tapers on GRE pipe in nominal pipe sizes 2" through 12". The motor operates on 120V or 230V and comes with a flex cable 7 ft. in length and the switch box is on an 8 ft. cable for safe operation.



**Photo 4**  
Grinding Tool - Model 10-612

### STARtec™ Threaded Connection Lubricant/Sealant

STARtec is a Teflon based lubricant that is used for the assembly of STAR API 10rd and 8rd Patented Advanced Composite Thread (ACT) and Precision Ground Thread (PGT) Connections. STARtec assures power tight makeup at low torque and allows easy breakout without seizing, stripping or galling. It also provides a permanent seal and maintains joint efficiency under vibration, pressure, surge, and temperature fluctuations. Use of any other lubricant can void the product warranty and requires special approval from Fiber Glass Systems. Startec is available in 1-gallon containers. **Do not use STARtec lubricant on Super Seal Connections.**



**Photo 5**  
STARtec

### Hi Pro Plus Kit

Hi Pro Plus is a two-part, manganese dioxide cured polysulfide based PTFE (polytetrafluoroethylene) filled sealant that is solvent free. Hi Pro Plus is used as pipe thread sealing compound for joining and coupling threaded oilfield pipe. The mixed compound has a paste consistency and can be readily applied with a spatula or brush to the threaded surfaces. It will cure to a fuel-resistant

rubber at temperatures above 60 °F with very low shrinkage. Hi Pro Plus exhibits excellent adhesion to a wide range of substrates including reinforced fiberglass, stainless steel, carbon steel, and galvanized pipe. Hi Pro Plus has superior chemical resistance to oils and fuels and should be considered on all 3000 psi, 4" 2500 psi, 6" 1500-2000 psi, and 8" 1000-2000 psi 8rd threaded products.

### **Do not use Hi Pro Plus on Super Seal Connections**

### **Epoxy Kit**

Epoxy kits are used for field fabrication of our patented 8rd molded threads or assembly of bonded fittings. The kit comes in either small or medium sizes and includes pre-measured epoxy and amine hardener.

Also, included in the kit are complete mixing instructions, a small piece of sand paper and a mixing stick.

### **Pin Molds**

Fiber Glass Systems manufactures threaded pin molds for field fabrication of STAR API 10rd and 8rd molded threads for use with the Epoxy Kits. The precision molds are made from hardened alloy steel, which if properly maintained can be used repeatedly to mold numerous threads.

Prior to attempting to use a mold, several items must be addressed, such as the pipe outside diameter and ensuring all the required accessories for applying threads are available. Reference Pg. 70-74 for complete instructions and procedures on making field threads.

### **Heat Collars**

Electric heat collars are used for the



**Photo 6**  
Hi Pro Plus



**Photo 7**  
Epoxy Kits



**Photo 8**  
Pin Molds



**Photo 9**  
Heat Collar



purpose of curing field threads or bonded connections. They are available in a variety of sizes and ordered by the nominal pipe size. Specify either 110V or 220V-240V when ordering. Chemical heat packs are also available.

### **Woven Roving**

Woven roving glass mat is used for increasing the outside diameter of a pipe body to the correct size for a pin mold inside diameter when the pipe outside diameter is insufficient to apply a field thread. Application of this material requires the use of an Epoxy Kit and special training by a Fiber Glass Systems representative.



**Photo 10**  
Woven Roving

### **Pipe Roller / Cradle**

The pipe roller/cradle is designed to help support and keep large diameter pipe, typically 6" and above, aligned during makeup.



**Photo 11**  
Pipe Roller/Cradle

### **Centralizers**

Plastic centralizers are used to support and provide spacing for fiberglass pipe during insertions into a secondary pipe for road crossing or river crossings. The centralizers are made of lightweight high density polyethylene and are easy to install. Reference Pg. 21 for spacing.



**Photo 12**  
Centralizer

### **Standard Pull On End Seals**

End seals are used to seal off the ends of the conductor pipe when a fiberglass pipe is inserted, such as at a road crossing or river crossing. The end seals protect the inside of the conductor pipe and the outside of the fiberglass pipe by eliminating the possibility of foreign material entering the annular space. Manufactured from 1/8" thick synthetic rubber, the Model S end seals are extremely robust and resistant to wide variations in environmental conditions.

# Section 3

## Receipt, Handling and Inspection

Transportation  
Load Inspection  
Unloading  
Storage  
Ultraviolet Effects  
Reshipping/Stringing Line Pipe

## Transportation

### Domestic U.S.A. or Inland Shipments Require:

- Dedicated (GRE Only) 34 ft. to 40 ft. flat bed or drop deck trailers (oil field hauler).
- Do not hang pipe off trailer.
- Transporting the pipe on racks above a small truck can cause potential impact damage.
- Use nylon straps for tie downs, do not use chains.
- Tie downs should be located near the dunnage, four locations minimum.

### International shipments require:

- Dedicated (GRE Only) 40 ft. either open top or high cube containers.
- All containers are loaded at the factory.
- It is highly recommended that the containers are not unloaded at port of destination.
- Shipments where the containers cannot be transported inland require the pipe to be crated at the factory.
- Crates can be installed inside of containers for removal at the port of destination and then transported inland.
- Seaworthy crates and insertion crates for containers are available

## Load Inspection

### Shipment inspection upon arrival:

- Check quantities, report deviations.
- Check for load shifting, and for missing dunnage.
- Check for excessive bending caused by over-tightening of straps.
- Check for missing thread protectors and thread damage. Replacement protectors are available and can be purchased. If thread protectors cannot be obtained, protect threads from sunlight with rags, cardboard, etc.

- Check for impact damage (blister caused by abrasion or blow with a sharp object).
- Quarantine or mark joints which appear damaged. Do not install damaged pipe. Contact your local distributor/agent or Fiber Glass Systems representative.
- Receiving party is responsible for noting shipping damage and contacting carrier.

## Unloading

### Common practices:

- Forklifts are commonly used to off load bundled pipe. Use a spotter to avoid damaging other bundles.
- Use padded forks when possible.
- Use a spreader bar and slings for off loading with a crane.
- Never allow pipe to roll off trailer to racks or ground.
- Breaking a bundle allows the pipe to move freely and can be off loaded individually.

## Storage

### Protect the pipe

- Set the pipe on a surface free of sharp rocks.
- Pipe bundles must not be stored directly on the ground.
- Leave the separator boards between the pipe layers.
- If pipe racks are used, strip them with lumber to protect the pipe from sharp edges.
- Use four racks equally spaced to avoid permanent bending particularly for long term storage.
- Storage of more than six months requires coverage with a tarp.
- Thread protection must remain in place to avoid degradation of thread tolerances.

## Ultraviolet Effects

- Ultraviolet effects on the pipe are limited to surface discoloration. Eventually, “fiber bloom” or fusing will occur if the pipe is left exposed to the sun long enough. The degradation is limited to the outer 0.005”-0.010” (0.13-0.25 mm) of the pipe. (Reference Table 2.)
- Fiberglass pipe may be protected from the ultraviolet rays by painting with a heavily pigmented industrial coating or by coating with an ultraviolet absorbing agent.
- Since STAR Line Pipe has an added safety factor, the surface effect of ultraviolet is minimum and does not reduce the long-term performance of these products significantly.

**Table 2**

Ultraviolet Effects on GRE Pipe

<b>Time Exposure</b>	<b>Pipe Conditions</b>
6 months	Pipe color changes from amber/green to tan. No effect on physical properties
1 year	Pipe color becomes dull tan and shiny fibers become visible. No effect on physical properties
2 years	Approximately 50% of the pipe surface shows shiny fibers. No effect on physical properties
3 years	Approximately 90% of the pipe surface shows shiny fibers. No effect on physical properties
5 years	Pipe will be fuzzy with the entire outer layer of glass exposed. No further damage to pipe will occur. Pipe will operate at 100% of rating.

## Reshipping and Stringing Line Pipe

### Necessary precautions include:

- Loose pipe must be loaded with the joints staggered.
- Separate each layer of pipe with wooden dunnage.



**CAUTION:** Never groove pipe and pyramid.

- Always use nylon straps to tie down pipe, never chains.
- Do not drop pipe off the trucks.
- Place uprights on the trailer to keep the pipe from falling off the trailer while stringing.
- Avoid sharp rocks
- Lay the pipe on the opposite side of the ditch from where the dirt is piles.
- It is recommended not to string out more pipe than can be installed in one day.
- If more than 1 day's installation is strung out, it is recommended to support the pipe with a minimum of 4 contact points to prevent bending or bowing of the pipe which could make joining difficult.
- Do not remove thread protectors prior to installation and joint assembly.

# Section 4

## Line Pipe Installation

Burial Guidelines  
Ditch Preparation  
Backfill Guidelines  
Buried Installation  
Above Ground Installation

## Burial Guidelines

Below ground installations are preferred over above ground installations.

### Fluid Applications:

- Minimum burial depth of 3 ft (900 mm) of stable cover is recommended for high pressure pipe lines.
- Compacted, sandy or fine grain soil installation conditions are preferred.
- Fiberglass line pipe must be buried below the freeze depth or insulated to protect against freezing.
- **Rocky conditions** require extra precaution of a minimum 6" (150 mm) of sand pad or select backfill around the pipe.
- The ditch bottom must be level such that the pipe does not bridge along the bottom.

### Gas Applications:

- **ALL gas applications** - Line pipe requires a minimum of 5 feet (1.5 mt) of stable cover.
- Additional service factors should be considered for gas applications.

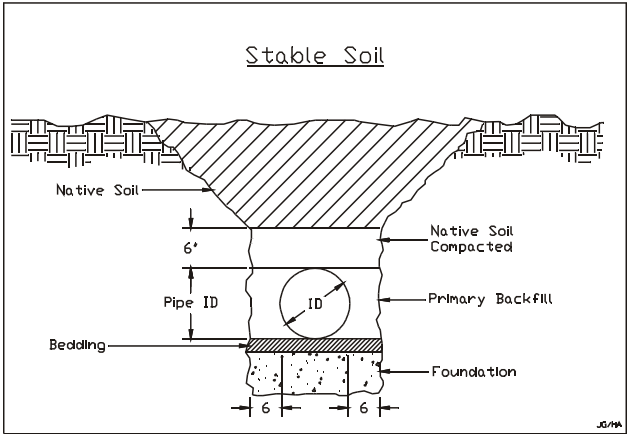
## Ditch Preparation

### Stable soil bedding procedures:

- Fiberglass pipe can be damaged by point contact or wear with the trench bottom and walls, improper bedding materials, or adjacent pipe.
- Remove all debris from ditch including tree roots, thread protectors, etc.
- Use recommended bedding material a minimum of 6 inches thick at the bottom, sides, and top of the piping.
- The pipe can be laid directly on the undisturbed trench bottom if the native soil meets the requirements of a recommended bedding material.
- Never lay fiberglass pipe directly against native rock, shale, caliche, etc.



- Always use dry, unfrozen bedding materials that does 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 system.
- Reference Figure 1.



**Figure 1- Stable soil installation**

### Swampy, unstable soil procedures:

First, attempt to excavate deep enough to find a stable layer of soil. If this is not possible, there are several options.

- A. Saddle bag style weights can be used to prevent pipe from floating in unstable soil.
- B. Special anchors can be designed to prevent pipe from floating or raising. These anchors are designed depending on the conditions. Many are 360° saddles around the pipe that are welded to work over rig type screw anchors (Figure 2).

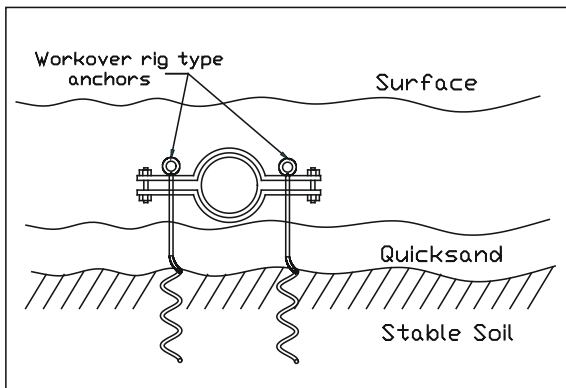


Figure 2 - Workover Rig Type Anchors

- C. **Stabilization of the soil** can be achieved with a filter cloth such as Geotex<sup>®</sup>. This material has proven useful to stabilize the ditch bottom in boggy, wet conditions. Geotextile can be placed below the pipe to reduce sinking and above the pipe to stabilize backfill (Figure 3).
- D. Steel casing with end seals may become necessary in the event that a stable bottom cannot be found or Geotextile will not work. Centralizers are required if steel casing is used.

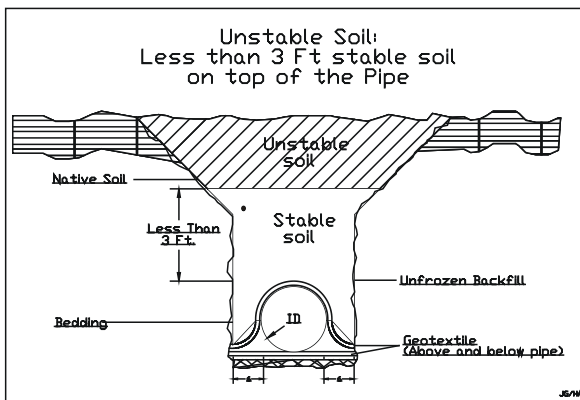


Figure 3 - Geotextile installation

## Frozen Soil

Stabilization of the ditch in some regions, such as Canadian muskeg, may only be possible in the winter when the ground is frozen. The following are some techniques which have been used successfully:

- Prior to installing the pipe gradual compaction of the ice can be achieved by driving over the pipe route with light vehicles over a period of time.
- The ditch is prepared by first pushing away the snow and then excavating the surface ice. Lay the surface ice away from the installation area so it does not become mixed with the unfrozen material.
- Excavate until you find a stable layer of soil. If this is not possible, use Geotextile and sand bags.
- Steel casing with end seals may become necessary in the event that a stable bottom cannot be found or Geotextile will not work.
- Since frozen backfill cannot be put in the pipe zone, it is recommended that the pipe is installed as the ditch is excavated.
- Backfill which has been excavated and left overnight will freeze. This material cannot be used in the pipe zone.
- Never attempt to compact backfill by driving heavy vehicles on the ditch line.
- Preparing the ditch before the line is laid will require additional work to remove snow and fall-in off the sides of the ditch.

## Backfill Guidelines

- Loose backfill free of large rocks or debris must be used in the pipe zone (6" (150 mm) around the pipe).
- Reference Table 3 for bedding material recommendations.
- Bedding material should be sifted into the ditch to ensure proper pipe support beneath and on the sides of the pipe.

- Backfill leaving 2' (600 mm) on each side of connections exposed for inspection during hydro test.
- **Do not backfill over connections until hydrotesting is complete.**
- Use thrust blocks or support for pipe and fittings if necessary.
- Cold weather backfilling with frozen material in the pipe zone must be avoided since impact damage can occur.
- Never compress the backfill on top of the pipe by driving heavy equipment on the ditch line as this can damage the pipe.
- Do not backfill a ditch full of water. Pump the ditch out and check the layout for voids beneath the pipe. Fill any voids that are found then backfill with dry soil.
- Swampy areas with unstable soil require special attention. Anchors or steel casing may be required in some instances.

### Table 3

Recommended Bedding Materials

Bedding Material	Compaction Protor Density
Crushed rock or pea gravel $\frac{3}{4}$ " 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%

## Buried Installation

### Joining Connections Above Ground

- Do not exceed the minimum bend radius or the maximum deflection when lowering the pipe into the ditch.
- Exercise caution not to over bend the pipe during the process of lowering it into the ditch. Reference Table 4.
- Never allow the pipe to whip into the ditch on its own weight.
- Always use nylon straps or pipe rollers to lift the pipe. Never use chains for lifting the pipe.
- Construction of a side boom support cradle has proven successful for heavy pipe support and leveling
- Use only straps for handling pipe, never chains.

### Joining Connections in the Ditch (“Including” Cross Lines or Repairs)

- Requires attention to wrench movement.
- The ditch width must accommodate full movement of the wrenches or it must be widened (bell holes) at the connections.

### Road Crossings (Figure 4)

- Road crossings require steel casing, centralizers and end seals.
- Protect the pipe at the entry and exit of casing against settling shear from sharp edges.
- Avoid over bending pipe to enter or exit road bore casings.
- Either prepare the ditch for a gradual elevation change, or use fittings.
- Stabilize soil beneath casing to minimize settling.
- Sand bags may provide sufficient thrust restraint or support, if necessary.
- Centralizers should be used to support pipe within casing.

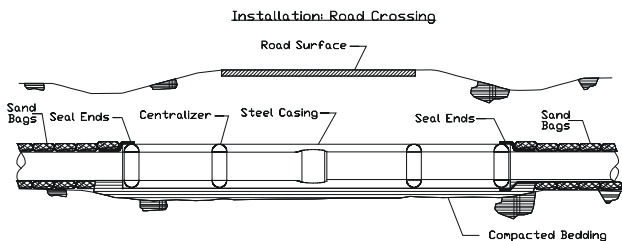


Figure 4- Road crossing

- **Line Crossings** (Figure 5)
- Line crossings must be padded for abrasion.
- It is common practice to install the fiberglass under existing lines when possible.
- Good practice is to leave a minimum of 12" (300 mm) between lines.

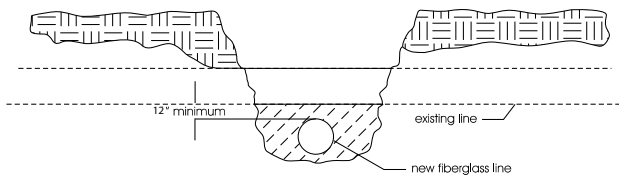


Figure 5- Line crossing burial depth

## Multiple lines

- Multiple lines laid in a single ditch require a minimum spacing of 6 inches (150 mm) clearance between connections. It is recommended that sufficient spacing is allowed for flange sets to be installed. Reference Table 13 for flange dimensions.

## Pulling Pipe

- If you need to pull pipe, make sure the short-term tensile rating of the pipe is not exceeded.
- If possible, use a weight indicator to ensure the short-term tensile rating of the pipe is not exceeded.

- Make sure there are no sharp objects, rocks, etc. that the pipe will be pulled over. This can cause damage to the pipe.
- The pipe should be monitored during the pull to ensure it does not get caught or stuck.

### Fittings Thrust Blocks

- It is the responsibility of the engineer to evaluate the need and design for thrust blocks. A complete evaluation must consider the combined effects of temperature changes, internal pressure surges and pipeline geometry.
- Pipe, components and joints are intended to operate safely with maximum free end internal pressure thrust, axial loads in excess of those produced by operating at maximum internal pressure rating should be considered for external thrust restraint.
- Thrust blocks should be considered at directional changes where the pipeline may approach its axial stress limits. Higher pressure rated components cannot be used to compensate for additional loading.

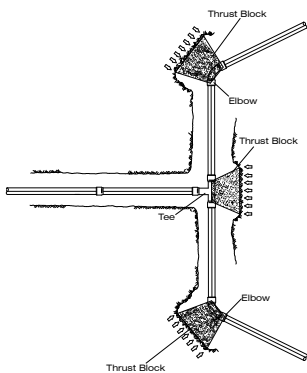


Figure 5 - Thrust blocks

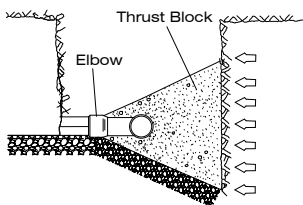
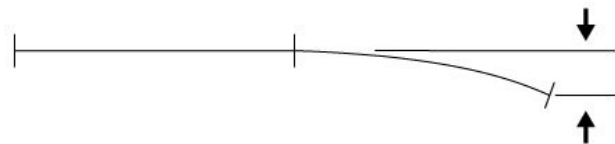


Figure 6 - Thrust block

## Maximum Deflection

- **Avoid over bending** pipe by avoiding sharp horizontal and vertical changes. Do not install pipe at less than the minimum bending radius or exceed the maximum deflection per 30 feet, see Maximum Deflections Table 4.

**NOTE:** Below 32°F (0°C) reduce allowable maximum deflection



Temperature °C	0	-20	-40
Multiplier	0.9	0.8	0.7



**Table 4a**

Maximum Deflections (per 30' joint) - Standard Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine
in		in	in/30 ft	in/30 ft
<b>Series 500</b>				
3"	3 1/2" 8rd	2.94	-	34
4"	4 1/2" 8rd	3.75	27	-
	4 1/2" 8rd	3.85	-	26
	4 1/2" 8rd	3.91	26	-
5"	5 1/2" 8rd	4.74	22	21
6"	6 5/8" 8rd	5.50	18	-
	6 5/8" 8rd	5.85	17	-
	6 5/8" 8rd	5.94	-	17
	6" SPH	6.10	17	-
8"	8 5/8" 8rd	7.50	13	-
	8" SS	7.74	-	13
	8 5/8" 8rd	7.74	-	13
10"	10" SS	9.84	-	10
12"	12" SS	11.81	-	8
<b>Series 800</b>				
2"	2-3/8" 8rd	1.94	-	50
2-1/2"	2-7/8" 8rd	2.37	-	42
3"	3-1/2" 8rd	2.94	-	34
	3-1/2" 8rd	3	33	-
	3" SP	3	33	-
4"	4-1/2" 8rd	3.75	27	-
	4-1/2" 8rd	3.85	-	26
	4-1/2" 8rd	3.91	26	-
	4" SP	3.91	26	-
5"	5-1/2" 8rd	4.74	21	21
6"	6-5/8" 8rd	5.50	18	18
	6-5/8" 8rd	5.85	17	-
	6-5/8" 8rd	5.94	-	17
	6" SPH	6.1	16	-
8"	8-5/8" 8rd	7.5	13	-
	8-5/8" 8rd	7.74	-	13
	8" SS	7.74	-	13
10"	10" SS	9.84	-	10
12"	12" SS	11.81	-	8

**Table 4a** (continued)

Maximum Deflections (per 30' joint) - Standard Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine
in		in	in/30 ft	in/30 ft
<b>Series 1000</b>				
2"	2 3/8" 8rd	1.94	-	50
2 1/2"	2 7/8" 8rd	2.37	-	42
	2 7/8" 8rd	2.375	42	-
	2 7/8" 8rd	2.43	41	-
3"	3 1/2" 8rd	2.94	-	34
	3 1/2" 8rd	3.00	33	-
	3" SP	3.00	33	-
4"	4 1/2" 8rd	3.75	26	-
	4 1/2" 8rd	3.85	-	26
	4 1/2" 8rd	3.91	25	-
	4" SP	3.91	25	-
5"	5 1/2" 8rd	4.74	21	21
6"	6 5/8" 8rd	5.85	17	-
	6 5/8" 8rd	5.50	18	18
	6 5/8" 8rd	5.94	-	16
	6" SPH	6.10	17	-
8"	8" HP SSS	7.485	13	-
	8 5/8" 8rd	7.50	13	-
	8 5/8" 8rd	7.74	-	13
	8" SS	7.74	-	13
10"	10" SS	9.84	-	10
	10" HP SSS	9.84	10	-
12"	12" SS	11.81	-	8
	12" HP SSS	11.81	8	-
<b>Series 1250</b>				
2"	2 3/8" 8rd	1.94	-	50
	2" SP	1.95	50	-
	2 3/8" 8rd	2.00	49	-
2 1/2"	2 7/8" 8rd	2.37	-	41
	2 7/8" 8rd	2.375	41	-
	2 7/8" 8rd	2.43	40	-
3"	3 1/2" 8rd	2.94	-	33
	3 1/2" 8rd	3.00	32	-
	3" SP	3.00	32	-

**Table 4a** (continued)

Maximum Deflections (per 30' joint) - Standard Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine
in		in	in/30 ft	in/30 ft
<b>Series 1250</b>				
4"	4 ½" 8rd	3.75	26	-
	4 ½" 8rd	3.85	-	25
	4 ½" 8rd	3.91	25	-
	4" SP	3.91	25	-
5"	5 ½" 8rd	4.74	20	20
6"	6 ⅝" 8rd	5.50	18	17
	6 ⅝" 8rd	5.85	16	-
	7" 8rd	5.94	-	16
	6" SPH	6.10	16	-
8"	8 ⅝" 8rd	7.44	-	13
	8 ⅝" 8rd	7.74	-	12
	8" SS	7.74	-	12
	8" HP SSS	7.485	13	-
	8 ⅝" 8rd	7.50	13	-
10"	10" SS	9.84	-	10
	10" HP SSS	9.84	10	-
12"	12" SS	11.81	-	8
	12" HP SSS	11.81	8	-
<b>Series 1500</b>				
1 ½"	1.90 10rd	1.44	-	66
	1.90 10rd	1.50	64	
2"	2 ⅜" 8rd	1.94	-	
	2" SP	1.95	49	
2 ½"	2 ⅜" 8rd	2.00	47	
	2 ⅞" 8rd	2.37	-	
	2 ⅞" 8rd	2.375	41	
3"	2 ⅞" 8rd	2.43	39	
	3 ½" 8rd	2.94	-	
	3 ½" 8rd	3.00	32	
4"	3" SP	3.00	32	
	4 ½" 8rd	3.75	25	
	4 ½" 8rd	3.85	-	
	4 ½" 8rd	3.91	24	
	4" SP	3.91	24	

**Table 4a** (continued)

Maximum Deflections (per 30' joint) - Standard Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine
in		in	in/30 ft	in/30 ft
<b>Series 1500</b>				
5"	5 1/2" 8rd	4.74	20	
6"	6 5/8" 8rd	5.50	17	
	6 5/8" 8rd	5.85	16	
	7" 8rd	5.94	-	
	6" SPH	6.10	16	
8"	8 5/8" 8rd	7.44	-	
	8" HP SSS	7.485	13	
	8 5/8" 8rd	7.50	13	
	9 5/8" 8rd	7.74	-	
10"	10" HP SSS	9.84	9	
12"	12" HP SSS	11.81	8	
<b>Series 1750</b>				
1 1/2"	1.90 10rd	1.44	-	65
	1.90 10rd	1.50	62	-
2"	2 3/8" 8rd	1.94	-	48
	2" SP	1.95	49	-
	2 3/8" 8rd	2.00	47	-
2 1/2"	2 7/8" 8rd	2.37	-	40
	2 7/8" 8rd	2.375	40	-
	2 7/8" 8rd	2.43	38	-
3"	3 1/2" 8rd	2.94	-	32
	3 1/2" 8rd	3.00	31	-
	3" SP	3.00	32	-
4"	4 1/2" 8rd	3.75	25	-
	4 1/2" 8rd	3.85	-	24
	4 1/2" 8rd	3.91	24	-
	4" SPH	3.91	24	-
5"	5 1/2" 8rd	4.74	20	20
6"	6-5/8" 8rd	5.50	17	17
	6" HP SSS	5.85	16	-
	7" 8rd	5.94	-	16
	6" SPH	6.10	15	-

**Table 4a** (continued)

Maximum Deflections (per 30' joint) - Standard Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine
in		in	in/30 ft	in/30 ft
<b>Series 1750</b>				
8"	8 5/8" 8rd	7.44	-	12
	8" HP SSS	7.485	12	-
	8 5/8" 8rd	7.50	12	-
	9 5/8" 8rd	7.74	-	12
10"	10" HP SSS	9.84	9	-
12"	12" HP SSS	11.81	8	-
<b>Series 2000</b>				
1 1/2"	1.90 10rd	1.44	-	63
	1.90 10rd	1.50	61	-
2"	2 3/8" 8rd	1.94	-	47
	2" SP	1.95	47	-
	2 3/8" 8rd	2.00	46	-
2 1/2"	2 7/8" 8rd	2.37	-	39
	2 7/8" 8rd	2.375	39	-
	2 7/8" 8rd	2.43	38	-
3"	3 1/2" 8rd	2.94	-	31
	3 1/2" 8rd	3.00	31	-
	3" SP	3.00	31	-
4"	4 1/2" 8rd	3.75	25	-
	4 1/2" 8rd	3.85	-	24
	4 1/2" 8rd	3.91	23	-
	4" SPH	3.91	23	-
5"	5 1/2" 8rd	4.74	19	19
6"	6 5/8" 8rd	5.50	17	17
	6" HP SSS	5.85	16	-
	7" 8rd	5.94	-	15
	6" SPH	6.10	15	-
8"	8 5/8" 8rd	7.44	-	12
	8" HP SSS	7.485	12	-
	9 5/8" 8rd	7.74	-	12
10"	10" HP SSS	9.84	9	-
12"	12" HP SSS	11.81	8	-

**Table 4a** (continued)

Maximum Deflections (per 30' joint) - Standard Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine
in		in	in/30 ft	in/30 ft
<b>Series 2500</b>				
1 ½"	1.90 10rd	1.44	-	62
	1.90 10rd	1.50	59	-
2"	2 ¾" 8rd	1.94	-	45
	2" SP	1.95	46	-
	2 ¾" 8rd	2.00	45	-
2 ½"	2 ⅞" 8rd	2.37	-	37
	2 ⅞" 8rd	2.375	38	-
	2 ⅞" 8rd	2.43	37	-
3"	3 ½" 8rd	2.94	-	30
	3 ½" 8rd	3.00	30	-
	3" SP	3.00	30	-
4"	4 ½" 8rd	3.75	24	-
	4 ½" 8rd	3.85	-	23
	4 ½" 8rd	3.91	23	-
	4" SPH	3.91	23	-
6"	6" HP SSS	5.85	15	-
8"	8" HPSSS	7.44	-	12
	8" HP SSS	7.485	12	-
10"	10" HP SSS	9.84	9	-
<b>Series 3000</b>				
1 ½"	1.90 10rd	1.44	-	60
	1.90 10rd	1.50	57	-
2"	2 ¾" 8rd	1.94	-	44
	2 ¾" 8rd	2.00	44	-
	2 ⅞" 8rd	2.37	-	36
2 ½"	2 ⅞" 8rd	2.375	37	-
	2 ⅞" 8rd	2.43	36	-
	2 ⅞" 8rd	2.43	36	-
3"	3 ½" 8rd	2.94	-	29
	3 ½" 8rd	3.00	29	-
	3" SP	3.00	29	-
4"	4 ½" 8rd	3.33	-	26
	4 ½" 8rd	3.75	23	-
	5 ½" 8rd	3.85	-	22
	4" SPH	3.91	22	-

**Table 4a** (continued)

Maximum Deflections (per 30' joint) - Standard Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine
in		in	in/30 ft	in/30 ft
<b>Series 3500</b>				
6"	6" HP SSS	5.85	15	-
8"	8" HPSSS	7.44	-	12
<b>Series 3500</b>				
1 ½"	1.90 10rd	1.44	-	57
2"	2 ¾" 8rd	1.94	-	42
2 ½"	2 ⅞" 8rd	2.37	-	35
3"	4 ½" 8rd	2.94	-	28
4"	4 ½" 8rd	3.33	-	25
	5 ½" 8rd	3.85	-	21
6"	6" HP SSS	5.85	14	-

**Table 4b**

Maximum Deflections (per 30' joint) - API Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine	Aromatic Amine
in		in	in/30 ft	in/30 ft	in/30 ft
<b>Series 500</b>					
2"	2" CEN	2.23	44	-	45
3"	3 1/2" 8rd	2.94	-	34	-
	3 1/2" 8rd	3.00	33	-	34
	3" CEN	3.35	30	-	30
4"	4 1/2" 8rd	3.75	27	-	-
	4 1/2" 8rd	3.85	-	26	-
	4 1/2" 8rd	3.91	26	-	26
5"	5 1/2" 8rd	4.74	21	21	-
6"	6 5/8" 8rd	5.50	18	-	18
	6 5/8" 8rd	5.85	17	-	17
	6 5/8" 8rd	5.94	-	17	-
	6" SPH	6.10	16	-	16
8"	8 5/8" 8rd	7.50	13	-	13
	8" SS	7.74	-	13	-
	8 5/8" 8rd	7.74	-	13	-
10"	10" SS	9.84	-	10	-
12"	12" SS	11.81	-	8	-
<b>Series 750</b>					
2"	2-3/8" 8rd	2.00	49	-	-
2-1/2"	2-7/8" 8rd	2.37	-	43	-
	2-7/8" 8rd	2.38	42		41
	2-7/8" 8rd	2.43	41		40
3"	3-1/2" 8rd	2.94	-	34	-
	3-1/2" 8rd	3.00	33		32
	3" SP	3.00	33		-
4"	4-1/2" 8rd	3.75	27		26
	4-1/2" 8rd	3.85	-	26	-
	4-1/2" 8rd	3.91	25		25
	4" SP	3.91	25		25
5"	5-1/2" 8rd	4.74	21	21	21
6"	6-5/8" 8rd	5.50	18	18	18
	6-5/8" 8rd	5.85	17		17
	6-5/8" 8rd	5.94	-	17	-
	6" SPH	6.10	16		16



**Table 4b** (continued)

Maximum Deflections (per 30' joint) - API Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine	Aromatic Amine
in		in	in/30 ft	in/30 ft	in/30 ft
<b>Series 750</b>					
8"	8-5/8" 8rd	7.50	13		13
	8-5/8" 8rd	7.74	-	13	-
	8" SS	7.74	-	13	-
10"	10" SS	9.84	-	10	-
12"	12" SS	11.81	-	9	-
<b>Series 1000</b>					
1 1/2"	1.90 10rd	1.50	64	-	-
2"	2 3/8" 8rd	1.94	-	51	-
	2 SP	1.95	50		49
	2 3/8" 8rd	2.00	49		48
2 1/2"	2 7/8" 8rd	2.37	-	42	-
	2 7/8" 8rd	2.38	41		41
	2 7/8" 8rd	2.43	40		40
3"	3 1/2" 8rd	2.94	-	34	-
	3 1/2" 8rd	3.00	32		32
	3" SP	3.00	32		32
4"	4 1/2" 8rd	3.75	26		26
	4 1/2" 8rd	3.85	-	26	-
	4 1/2" 8rd	3.91	25		24
	4" SP	3.91	25		24
5"	5 1/2" 8rd	4.74	20	21	20
6"	6 5/8" 8rd	5.50	18	18	17
	6 5/8" 8rd	5.85	17		16
	6 5/8" 8rd	5.94	-	17	-
	6" SPH	6.10	16		16
8"	8" HP SSS	7.49	13		13
	8 5/8" 8rd	7.50	13		13
	8 5/8" 8rd	7.74	-	13	-
	8" SS	7.74	-	13	-
10"	10" SS	9.84	-	10	-
	10" HP SSS	9.84	10		9
12"	12" SS	11.81	-	8	-
	12" HP SSS	11.81	8		8

**Table 4b** (continued)

Maximum Deflections (per 30' joint) - API Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine	Aromatic Amine
in		in	in/30 ft	in/30 ft	in/30 ft
<b>Series 1250</b>					
1 1/2"	1.90 10rd	1.50	63	-	-
2"	2 3/8" 8rd	1.94	-	50	-
	2" SP	1.95	49		48
	2 3/8" 8rd	2.00	47		47
2 1/2"	2 7/8" 8rd	2.37	-	41	-
	2 7/8" 8rd	2.38	41		40
	2 7/8" 8rd	2.43	39		39
3"	3 1/2" 8rd	2.94	-	33	-
	3 1/2" 8rd	3.00	32		31
	3" SP	3.00	32		31
4"	4 1/2" 8rd	3.75	25		25
	4 1/2" 8rd	3.85	-	25	-
	4 1/2" 8rd	3.91	24		24
	4" SP	3.91	24		24
5"	5 1/2" 8rd	4.74	20		20
6"	6 5/8" 8rd	5.50	17	18	-
	6 5/8" 8rd	5.85	16		-
	7" 8rd	5.94	-	16	-
	6" SPH	6.10	15		15
8"	8" HP SSS	7.49	13		12
	8 5/8" 8rd	7.50	12		12
	9 5/8" 8rd	7.74	-	13	-
10"	10" HP SSS	9.84	9		9
12"	12" HP SSS	11.81	8		8
<b>Series 1500</b>					
1 1/2"	1.90 10rd	1.44	-	65	-
	1.90 10rd	1.50	61		60
2"	2 3/8" 8rd	1.94	-	49	-
	2" SP	1.95	48		47
	2 3/8" 8rd	2.00	46		45
2 1/2"	2 7/8" 8rd	2.37	-	40	-
	2 7/8" 8rd	2.38	40		39
	2 7/8" 8rd	2.43	38		37

**Table 4b** (continued)

Maximum Deflections (per 30' joint) - API Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine	Aromatic Amine
in		in	in/30 ft	in/30 ft	in/30 ft
<b>Series 1500</b>					
3"	3 1/2" 8rd	2.94	-	32	-
	3 1/2" 8rd	3.00	31		30
	3" SP	3.00	31		31
4"	4 1/2" 8rd	3.75	25		24
	4 1/2" 8rd	3.85	-	25	-
	4 1/2" 8rd	3.91	24		23
	4" SP	3.91	24		-
	4" SPH	3.91	-		23
5"	5 1/2" 8rd	4.74	20		19
6"	6 5/8" 8rd	5.50	17	17	16
	6" HP SSS	5.85	16		15
	7" 8rd	5.94	-	16	-
	6" SPH	6.10	15		15
8"	8" HP SSS	7.49	12		12
	8 5/8" 8rd	7.50	12		-
10"	10" HP SSS	9.84	9		9
12"	12" HP SSS	11.81	8		-
<b>Series 1750</b>					
1 1/2"	1.90 10rd	1.44	-	63	-
	1.90 10rd	1.50	60		59
2"	2 3/8" 8rd	1.94	-	48	-
	2" SP	1.95	47		46
	2 3/8" 8rd	2.00	46		44
2 1/2"	2 7/8" 8rd	2.37	-	39	-
	2 7/8" 8rd	2.38	39		38
	2 7/8" 8rd	2.43	38		37
3"	3 1/2" 8rd	2.94	-	32	-
	3 1/2" 8rd	3.00	30		30
	3 1/2" 8rd	3	-		30
	3" SP	3.75	24		24
4"	4 1/2" 8rd	3.85	-	24	-
	4 1/2" 8rd	3.91	23		23
	4 1/2" 8rd	4.74	19		-
5"	5 1/2" 8rd	5.50	17	17	-

**Table 4b** (continued)

Maximum Deflections (per 30' joint) - API Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine	Aromatic Amine
in		in	in/30 ft	in/30 ft	in/30 ft
<b>Series 1750</b>					
6"	6 5/8" 8rd	5.85	16		15
	6" HP SSS	5.94	-	16	-
	7" 8rd	6.10	15		14
	6" SPH	7.49	12		12
8"	8" HP SSS	9.84	9		-
10"	10" HP SSS	11.81	7		-
12"	12" HP SSS	11.81	8		-
<b>Series 2000</b>					
1 1/2"	1.90 10rd	1.44	-	62	-
	1.90 10rd	1.50	59		57
2"	2 3/8" 8rd	1.94	-	47	-
	2" SP	1.95	46		45
	2 3/8" 8rd	2.00	45		43
2 1/2"	2 7/8" 8rd	2.37	-	38	-
	2 7/8" 8rd	2.38	38		37
	2 7/8" 8rd	2.43	37		36
3"	3 1/2" 8rd	2.94	-	31	-
	3" SP	3.00	30		29
	3 1/2" 8rd	3.00	30		29
4"	4 1/2" 8rd	3.75	24		23
	4 1/2" 8rd	3.85	-	24	-
	4 1/2" 8rd	3.91	23		-
	4" SPH	3.91	23		-
6"	6 5/8" 8rd	5.50	16		-
	7" 8rd	5.50	-	17	-
	6" HP SSS	5.85	15		15
	6" SPH	6.10	15		-
8"	8" HP SSS	7.49	12		11
10"	10" HP SSS	9.84	9		-
12"	12" HP SSS	11.81	7		-
<b>Series 2500</b>					
1 1/2"	1.90 10rd	1.44	-	60	-
	1.90 10rd	1.50	56		56

**Table 4b** (continued)

Maximum Deflections (per 30' joint) - API Design

Pipe Size	Thread Type	ID	Anhydride	Aliphatic Amine	Aromatic Amine
in		in	in/30 ft	in/30 ft	in/30 ft
<b>Series 2500</b>					
2"	2 3/8" 8rd	1.94	-	45	-
	2" SP	1.95	44		-
	2 3/8" 8rd	2.00	44		42
2 1/2"	2 7/8" 8rd	2.23	-		38
	2 7/8" 8rd	2.37	-	37	-
	2 7/8" 8rd	2.38	37		-
	2 7/8" 8rd	2.43	36		-
3"	3 1/2" 8rd	2.72	-		31
	3 1/2" 8rd	2.94	-	30	-
	3 1/2" 8rd	3.00	28		-
	3" SP	3.00	29		-
4"	4 1/2" 8rd	3.33	-	26	-
	4 1/2" 8rd	3.35	-		25
	4 1/2" 8rd	3.85	-	23	-
	5 1/2" 8rd	3.75	23		23
	4" SPH	3.91	22		-
6"	6" HP SSS	5.85	15		14
8"	8" HP SSS	7.49	11		-
<b>Series 3000</b>					
1 1/2"	1.90 10rd	1.44	-	57	-
	1.90 10rd	1.50	55		56
2"	2 3/8" 8rd	1.88	44		45
	2 3/8" 8rd	1.94	-	43	-
2 1/2"	2 7/8" 8rd	2.23	37		37
3"	3 1/2" 8rd	2.72	30		30
	4 1/2" 8rd	2.94	-	29	-
	3" SP	3.00	28		28
4"	4 1/2" 8rd	3.33	-	25	-
	5 1/2" 8rd	3.85	-	22	-
6"	6" HP SSS	5.85	14		14

## Transition From Buried To Above Ground

Transition to above-ground piping can be accomplished in several manners. Proper restraint of buried risers should be analyzed by the engineer or installer. (See Thrust Blocks)

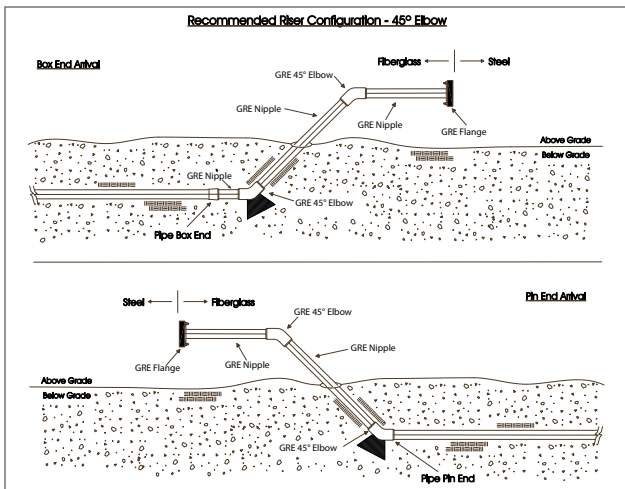


Figure 7 - Recommended riser configuration - 45° elbow

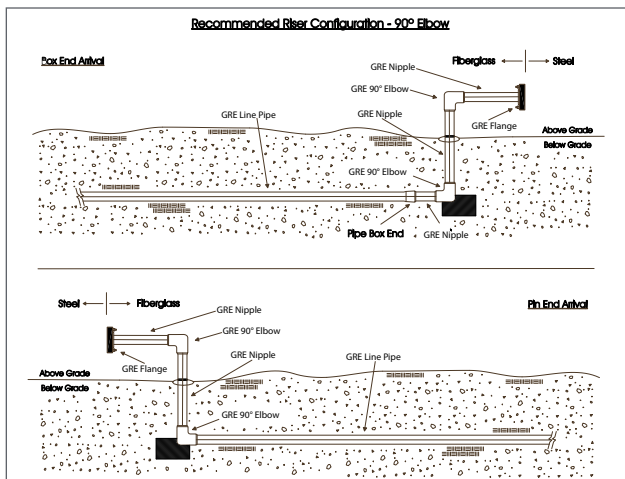


Figure 8 - Recommended riser configuration - 90° elbow

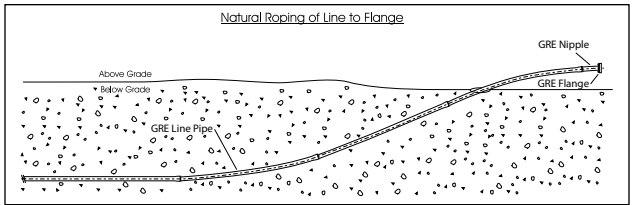


Figure 9- Natural roping of line to flange

## Above Ground Installation

### Support and Guide Spacing

- Contact Applications Engineering for support and guide spacing.
- The fiberglass pipe should never support the weight of any steel components.

### Wear Saddles

- Wear saddles 360° around the pipe must be used to protect the pipe against pulsation abrasion or pipe movement due to temperature fluctuation.

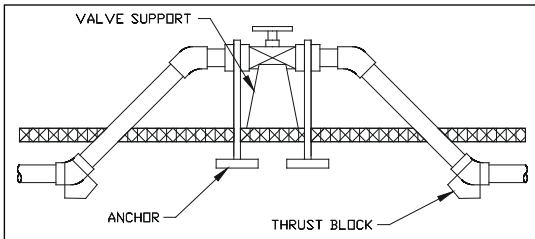


Figure 10 - Above ground valve support

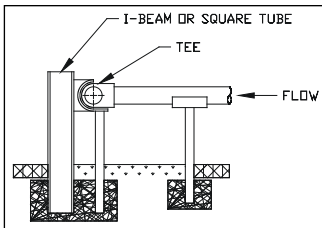


Figure 11 - Above ground thrust restraint

## UV Effects

- Reference Section 3 Ultraviolet Effects.

## Thrust Blocks

- Thrust blocks for above ground installation must be constructed to support fittings listed in Figures 10 & 11.
- The design must simulate the same support as buried concrete thrust blocks; abrasion padding is recommended.
- Thrust blocks may be required for above ground fittings.
- The need for thrust restraint should be considered by the system design engineer.



# Section 5

## STAR 10rd and 8rd Joint Assembly

Introduction  
Make-up Tools  
Precautions  
Cleaning and Inspection  
Lubricant  
Joining Procedure  
Lowering Pipe in the trench

## Introduction

Threaded connections manufactured to API 5B long-form specifications are provided as patented Advanced Composite Thread (ACT) or precision ground (PGT) thread. Depending on the size and pressure rating, the connection utilizes either a Teflon<sup>®</sup>-based lubricant (STARtec) or a proprietary sealant (Hi Pro Plus) to achieve the seal. All API threaded products can be installed using Hi Pro Plus. Table 4 lists by size and pressure the recommended lubricants and the estimated number of connections, which can be made up per container with daily installation rates.

## Make-Up Tools

Make-up tools are designed to provide uniform 360° compression on the pipe while applying the required make-up torque. The STAR friction wrench, along with one of three different strap wrenches, are required for proper make-up. Friction wrenches are designed to fit the cylindrical male end upset diameters. Use on conical shaped integral joint upset ends can cause point loading and damage to the pipe wall. Table 5 shows the combinations of recommended wrenches for each size pipe.

## Precautions

- Never use typical oil field pipe wrenches on fiberglass pipe. Chain tongs may be used on high pressure GRE fittings only.
- The strap wrench may be on male upsets and conical shaped integral female joint ends.
- Metal Friction Wrench (MFW) may only be used on the cylindrical pin end upset diameters.
- When using a torch to warm the pipe ends, be careful not to burn, delaminate, or damage the pipe. Do not exceed 130°F.
- Strap and friction wrenches are designed to fit around upset ends, not pipe bodies.

# Table 5

Recommended tools, lubricants, crew size and insallation rate

Thread Size	1.90	2 3/8	2 7/8	3 1/2	4	4 1/2	5 1/2	6 5/8	7	8 5/8	9 5/8
<b>Make-Up Length Loss (in)</b>	2.06	2.56	2.86	3.13	3.88	3.5	4.38	3.88	4.5	4.5	4.75
<b>Male Upset</b>	Metal Friction Wrench (MFW)										
<b>Strap Wrench Size</b>	No. 5			No. 11			MFW or No. 20		No. 20		No. 30
<b>STARTec (jts/gal)</b>	100	100	100	68	50	50	34	34	34	26	26
<b>Hi Pro Plus<sup>(1)</sup> (jts/gal)</b>	33	25	20	16	12	12	10	8	8	4	3
<b>Installation (feet/day)</b>	5000 to 7000 ft.	5000 to 7000 ft.	5000 to 6000 ft.	3000 to 4000 ft.	3000 to 4000 ft.	2000 to 3000 ft.	2000 to 3000 ft.	1000 to 2000 ft.	1000 to 2000 ft.	1000 to 2000 ft.	1000 to 2000 ft.
<b>Crew Size<sup>(2)</sup></b>	4 to 5	4 to 5	4 to 5	5 to 6	5 to 6	5 to 6	6	6	6	6	6
<b>Thread Standoff<sup>(3)</sup></b>	STAR industry standard API EUE 10rd, 8rd and OD 8rd threads are designed to advance to the "power tight" position with 2 thread standoff; 1 to 3 thread standoff, are typical due to manufacturing tolerances										
<b>Min. Torque (ft•lb)</b>	100	125	150	175	Reference thread standoff						
<b>Opt. Torque (ft•lb)</b>	125	150	185	225	Reference thread standoff						
<b>Max. Torque (ft•lb)</b>	175	225	250	300	Reference thread standoff						

<sup>(1)</sup> Do not use Hi Pro Plus if it has started to setup.

<sup>(2)</sup> Crew size includes contractor supervisor.

<sup>(3)</sup> Torque and thread standoff should be monitored for 1.90", 2 3/8", 2 7/8", and 3 1/2" threads. Care must be taken to ensure excessive torque is not required for proper standoff.

## Cleaning and Inspection

- Thread protectors must be left in place until just before joining pipe.
- Ice will make thread protectors impossible to remove. Heat the ends of the pipe with a propane torch to melt the ice.
- If an open flame is not permitted, methyl alcohol can be used to melt the ice or a heat blanket (electric or chemical) may be used.
- Clean threads with a soft bristle brush (solvents can be used, but the threads must be dried thoroughly).
- Sand, dirt, ice or other debris must be removed from the threads prior to joining.

## Lubricant

Two different lubricants are available for use with API threaded connections.

The standard lubricant is a Teflon-based lubricant, STARtec, which offers excellent lubrication for ease of make up along with optimum sealing characteristics.

A specialty two-part thread sealant, Hi Pro Plus, can be used on all API threaded connections. When cured, Hi Pro Plus becomes a solid thread seal. The primary usage of Hi Pro Plus is for high pressure applications or when field installation expertise is limited. Installations where Hi Pro Plus should be considered are on all 3000 psi, 4" 2500 psi, 6" 1500-2000 psi and 8" 1000-2000 psi products. Hi Pro Plus works best on installations above 50°F (10°C). When ordering Hi Pro Plus, specification of job site temperature is required. Curing of Hi Pro Plus at low temperatures can be accelerated by the use of electric heat blankets.

**NOTE:** STARtec lubricant or Hi Pro Plus thread sealant must be used to maintain the warranty of Fiber Glass Systems products.

## STARtec Lubricant

- Apply lubricant evenly with a typical lube brush to both the male and female threads (the entire base of the thread must be coated).

- The lubricant must be kept warm 65°F (18.3°C) in order to apply it evenly.
- Never use solvent to thin the lubricant, even in cold weather.
- Agitate or stir the lubricant frequently to keep it from balling.



## Hi-Pro Plus Thread Sealant

- Hi-Pro Plus requires mixing of ingredients prior to using.
- Using the wooden stir stick, scoop out all of the contents of hardener Component B into jar of base Component A. **Do not split the kit.** The base is a light-colored paste; the hardener is a dark paste.
- Thoroughly mix the two components together until a uniform color is achieved and the particles in the bottom of the container are evenly dispersed.
- Use the brush provided to spread a thin, even coat of sealant on all exposed pin and box threads, removing any excess.
- If the sealant is difficult to spread, warm the joint enough for the sealant to spread easily. Do not overheat.
- The cure of Hi Pro Plus below temperatures of 50°F (10°C) requires the use of electric heat blankets.
- **Hi Pro Plus must be fully cured prior to hydro testing.**



## Joining Procedure

- Support pipe behind the female end to allow tool movement and leveling.
- **Alignment** is very important for full thread engagement (particularly on large diameter pipe).

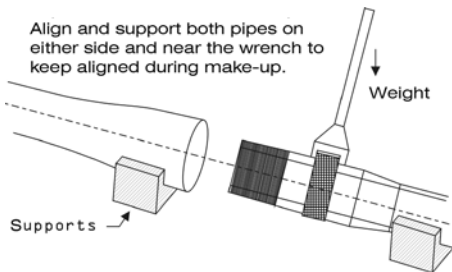


Figure 12

- Weather near or below freezing requires heating of the male and female ends with a propane torch or electric heating collar. The ends shall feel warm by touch to the back of your hand.
- Apply lubricant.
- Stab the joint gently until full engagement is felt.

- **Avoid cross threading** by careful alignment.

- Rotate the pipe by hand.

- Rotation of the pipe can be assisted by using a strap wrench or a spinning tong. (see Figure 12)

- **Cross-threaded connections** must be backed out, cleaned and inspected for damage. If the threads pass the inspection, restart the joining procedure.



- **Final torque** is applied using a friction wrench on the male upset only and a strap wrench on the female connection with wrenches close to connection. A strap wrench maybe used on the male end also.

- **STARAPI** threaded connection are designed to allow torque control monitoring the joint make-up position. (Refer to Table 5 for thread standoff)

- Some instances may require a handle extension on the wrench which will reduce the required force to reach full makeup.
- The use of an abrasive powder may be needed to prevent slippage of strap wrench on final torque.
- Power tongs can be effectively used on sizes 4" (2500-3500 psi), 6" (1500-2500 psi), and 8" (1000-2000 psi).

### **Lowering pipe in trench (Roping)**

- Exercise caution not to over bend the pipe during the process of lowering it into the ditch. (See Table 3, for Maximum Deflection).
- Never allow the pipe to whip into the ditch on its own weight.
- Always use straps on the pipe, Never use chains for lifting.
- Construction of a side boom support cradle has proven successful for heavy pipe support and leveling.

# Section 6

## STAR Super Seal Joint Assembly

Introduction  
Make-up Tools  
Standare O-ring Sizes and Types  
Precautions  
Lubricants  
Cleaning and Inspection  
Joining Procedure  
Final Make-Up



## STAR Super Seal

### Introduction

STAR Super Seal Line Pipe offers 5 proprietary thread types: CEN, SP, SPH, SS, and SS-HP.

The STAR Super Seal threads are very coarse when compared to typical industry threads, such as, NPT and API 8rd threads. The coarse threads provide a fast and reliable installation, and are difficult to cross-thread which is extremely beneficial, especially, for large diameter products. The seal is achieved by compressing an O-ring between two mating surfaces.

**Table 6**

STAR Super Seal Connections

Resin System	Thread	Pipe Size	Thread Count (TPI)	Thread Length (in)
STAR Anhydride	CEN	2"-3"	4	4.9
	SP	2"-4"	4	4.5
	SPH	4"	4	4.5
	SPH	6"	4	6.0
	SS-HP	6"-12"	2	9.0
STAR Aliphatic Amine	SS	8"	2	5.0
	SS	10"	2	6.2
	SS	12"	2	6.9
STAR Aromatic Amine	CEN	2"-3"	4	4.9
	SP	2"-4"	4	4.5
	SPH	4"	4	4.5
	SPH	6"	4	6.0
	SS-HP	6"-12"	2	9.0

### Makeup Tools

- Strap wrenches are designed to provide a uniform 360° compression on the pipe while applying the required makeup torque.
- Strap wrenches are required for proper makeup (Reference Table 7).

Strap wrenches allow the installer to “feel” the O-ring seal engagement. Power tool makeup provides no “feel” or feedback to operator and are not recommended.

- **Pipe Roller / Cradle** can assist with support, alignment, and rotation especially for large diameter pipe, typically 6” and above.

## Standard O-ring Sizes and Types

- Buna N Nitrile 70 durometer is the standard O-ring material.
- Alternative elastomers are available and may be better suited for your specific application. i.e. Explosives decompression, gas service, CO<sub>2</sub>, etc. Reference Table 9 for general O-ring material guidelines.

**NOTE:** There are hundreds of varieties of each compound available and are not all equivalent.

- It is recommended that extra O-rings are ordered and kept on the installation site for replacement of any that are found damaged or missing (Reference Table 8).
- O-rings are shipped separate from the pipe.
- During cold weather installations, keep the O-rings and lubricants warm.

## Precautions

- Never use typical oilfield pipe wrenches on fiberglass pipe. Chain tongs may be used on high pressure fiberglass fittings only.
- When using a torch to warm the pipe ends, be careful not to burn, delaminate, or damage the pipe. Do not exceed 130°F.
- The strap wrenches should only be used on the pin upset and box buildup ends.



**CAUTION:** Do not overtighten the connection, the O-ring will make the seal.

Table 7

Super Seal Makeup Tools

Pipe Size (in)	2		3		4		6		8		10		12	
	CEN	SP	CEN	SP	SP	SPH	SPH	SS-HP	SS	SS-HP	SS	SS-HP	SS	SS-HP
<b>Thread Type</b>														
<b>Make-Up Length Loss (in)</b>	4.9	4.5	4.9	4.5	4.5	4.5	6.0	8.8	4.8	8.8	5.4	8.8	6.1	8.8
<b>Male Upset</b>	No. 5						No. 11							
<b>IJ Female</b>	No. 5						No. 11							
<b>Installation (feet/day)</b>	6500 to 9100 ft.		3900 to 5200 ft.		2600 to 3900 ft.		2000 to 3000 ft.		1800 to 2800 ft.		1500 to 2500 ft.		1500 to 2000 ft.	
<b>Crew Size<sup>(1)</sup></b>	3 to 4		4 to 5		4 to 5		5 to 6		5 to 6		5 to 6		5 to 6	
<b>Max. Standoff</b>	1/4"	1/4"	1/4"	1/4"	1/4"	1/4"	1/4"	1 1/2"	1 1/4"	1 1/2"	1 5/8"	1 1/2"	1 5/16"	1 1/2"

<sup>(1)</sup> Crew size includes contractor supervisor.

## Lubricant

- Do not use thread compounds of any kind.
- Lubricants must be protected from contamination by dirt, sand, and debris.
- Clean, white lithium grease (non-aerosolized) is recommended for joint makeup.
- Clean hydraulic fluid, light-weight motor oil, or silicone based lubes can also be used for joint makeup.

**Table 8**

O-ring Size Chart

<b>Super Seal Thread</b>	<b>Pipe Size (in)</b>	<b>Dash Number</b>
<b>CEN</b>	2"	141
	3"	152
<b>SP</b>	2"	226
	3"	236
	4"	244
<b>SPH</b>	4"	346
	6"	438
<b>SS</b>	8"	369
	10"	449
	12"	453
<b>SS-HP</b>	6"	439
	8"	445
	10"	450
	12"	454

## Cleaning and Inspection

- Each joint must be checked visually for shipping and/or handling damage. Shallow scratches and abrasions are generally insignificant, but if the pipe has cuts in the laminate, bruises, or fractures, it should be set aside for replacement. If unsure whether the pipe is damaged, contact a Fiber Glass Systems Representative.

**Table 9**

General Guidelines for O-ring Compatibility

<b>Media</b>	<b>HNBR</b>	<b>Nitrile Buna-N</b>	<b>Ethylene Propylene</b>	<b>Viton Fluorocarbon</b>	<b>Aflas</b>
<b>Amines</b>	Good	Poor	Excellent	Poor	Excellent
<b>CO<sub>2</sub></b>	Excellent	Good <sup>(1)</sup>	Good <sup>(1)</sup>	Good <sup>(1)</sup>	Excellent <sup>(2)</sup>
<b>Crude Oil</b>	Excellent	Excellent	Poor	Excellent	Good
<b>H<sub>2</sub>S (15%)</b>	Excellent	Poor <sup>(3)</sup>	Excellent	Good	Good
<b>Kerosene</b>	Excellent	Excellent	Poor	Excellent	Good
<b>Methane</b>	Excellent	Excellent	Excellent	Excellent	Excellent
<b>Steam</b>	Excellent	Poor	Excellent	Good	Excellent
<b>Saltwater</b>	Excellent	Excellent	Excellent	Good	Excellent

- Thread protectors must be left in place until just before joining pipe.
- Ice will make thread protectors impossible to remove. Heat the ends of the pipe with a propane torch to melt the ice.
- If an open flame is not permitted, methyl alcohol, electric heat blanket, or a chemical heat pack can be used to melt the ice.
- After removal of thread protectors, inspect the box, pin, and sealing surfaces for damage. Remove any contamination from the box, pin, and sealing surfaces.
- Installer should ensure that no contamination can enter the joint prior to makeup.
- Any foreign material at the O-ring seal can cause leakage. This includes grass, sand, lubricant, brush bristles, etc.
- Inspect O-ring making sure it is clean with no nicks, cuts, or gouges.
- If the surfaces are contaminated, clean with the use of a soft bristle brush and water. Do not use metal brushes or compounds containing solvents for cleaning.
- Sand, dirt, ice, or other debris must be removed from the threads prior to joining.
- Contamination inside the pipe, not in the joint and seal area, can fall into the joint during alignment. Keep pipe stored off the ground with protectors in place until ready to join.

## **Joining Procedure**

### **Lubrication and O-ring Procedure**

- Lightly lubricate the female threads, male threads, O-ring seating area, and O-ring sealing area.
- Lubricate the O-ring and place the O-ring into the seating area.

### **Alignment**

- If the pipe is too heavy to hold and makeup by hand then side-boom with nylon straps and/or pipe rollers / cradles should be used to support and lift the pipe.

- The nylon straps or pipe rollers / cradles are typically placed around the middle of the pipe during the alignment, insertion, and rotating operations.
- Do not use chains for lifting the pipe.
- If the pipe is light enough to lift by hand then a plastic pipe cone or pipe jack can be used for support and assistance with alignment.
- **Proper alignment of the two joints is critical.**

### Final Makeup for CEN, SP, and SPH

- You should be able to rotate the pipe by hand if proper alignment is achieved. For large diameter pipe, a No. 5 strap wrench may be needed to assist in pipe rotation.
- The makeup will gently slow as the O-ring compresses.
- At this time, you may need to switch from the No. 5 strap wrench to a No. 11 strap wrench. Reference Table 7 for strap wrench recommendations.
- Final makeup is achieved when standoff from pin shoulder to the face of the box is at a 1/4". The CEN pin will have a white mark on the thread which will be entirely covered when final makeup is achieved.
- Do not shoulder out the connection.
- Once final makeup is achieved, you may back-out a 1/4 rotation for fitting alignment. If more than 1/4 rotation is required, revert to next nearest joint.
- If standoff distance exceeds .25", then the joint should be disassembled and inspected for damage or debris and the O-ring inspected for damage. If no damage is observed, repeat the makeup procedure, and if the problem persists, set the joint aside for disposition.

**NOTE:** CEN jointed pipe ( $\leq 500$ -psi) is designed for tapered and bonded fittings. Reference Section 9 and INS1000 (Installation Handbook for Matched Tapered Bell x Spigot Joints) for bonding procedures.

### Final Makeup for SS

- Sub-freezing temperatures require the warming of the male and female ends of the pipe.

- Check alignment to prevent O-ring and/or connection damage. Pipe rollers / cradles are recommended for lifting, alignment, and pipe rotation.
- The 8", 10", and 12" Super Seal connections are match marked for thread engagement. Align the starter thread marks on the male and female prior to engagement.
- Turn the connection slowly to the right by hand until the threads engage.
- The makeup will gently slow as the O-ring compresses.
- Use of the strap wrenches will become necessary as rotation becomes difficult. Reference Table 7 for strap wrench recommendations.
- The makeup will stop abruptly.
- Once final makeup is achieved, you may back-out 1/4 rotation for fitting alignment. If more than 1/4 rotation is required, revert to next nearest joint.
- Installation rates and crew sizes are listed in Table 7. Improved rates can be achieved depending on crew and conditions.

### **Final Makeup SS-HP**

- Check alignment to prevent O-ring and/or connection damage. Pipe rollers / cradles are recommended for lifting, alignment and pipe rotation.
- Insert the pin threads into the box. Because the threads are tapered, the pin may be inserted deep into the box before thread engagement occurs.
- Turn the pipe slowly to the right by hand until the threads engage. Ensure that the joint is aligned and not crossthreaded.
- Continue to make the connection by hand until the joint will not turn anymore. Rotation should be very smooth if proper alignment is maintained.
- Listen for rubbing or grinding noises and, if present, recheck alignment before additional rotation.



- Continue to make the connection with a strap wrench until the O-ring is compressed in the seal bore.
- The connection should be made-up until the thread standoff distance falls between  $15/16$ " to  $1-7/16$ " with a maximum allowable thread standoff distance of  $1-1/2$ ".
- 800 to 1000 ft-lb torque will be required to fully seat the tapered pin into the tapered box.
- Once final makeup is achieved, you may back-out  $1/4$  rotation for fitting alignment. If more than  $1/4$  rotation is required, revert to next nearest joint.
- If a longer standoff distance is observed, then the joint should be disassembled and inspected for damage or debris and the O-ring inspected for damage. If no damage is observed, repeat the makeup procedure, and if the problem persists, set the joint aside for disposition.

# Section 7

## Field Hydrostatic Testing

Frequency  
Preparation  
Testing  
Locating a Leak

## Frequency

- Field hydrostatic pressure testing is recommended on all lines to ensure line integrity and field workmanship.
- Testing is recommended at the following intervals of the installation:
  - STAR high pressure line pipe – first 5,000-ft maximum.
  - Fitting intensive piping projects – first 50 joints maximum.

## Preparation

- Backfill must be sufficient to minimize pipe movement with 2-ft on either side of the connection left exposed for joint inspection.
- Soft pigs must be provided to fit the inside diameter of the pipe and fittings. Pigs are used to displace the air when filling the pipe with water.
- Test equipment should be capable of monitoring pressure and temperature as a function of time.



**CAUTION:** Test with fresh water. Gas and air are not recommended for proof testing. Produced water is not reliable as it is often contaminated and foamy.

- Testing at freezing or sub-freezing temperatures may require the mixing of up to 50% methyl alcohol with the fresh water used for hydrostatic testing. Other additives must be approved by FGS. Test equipment lines must also be filled with 50% methyl alcohol to prevent freezing.

## Testing

- Place two soft pigs in the line at the lower end of the line one behind the other. Pump the pig through the line by pushing it with fresh water.
- A 50% methyl alcohol may be mixed with water for subfreezing temperatures.
- Bleed the air at the highest elevation of the line since trapped air will become compressed during testing and will give erroneous results.

- If water appears before the pig, air may be trapped in the line.
- Beware of water temperatures versus the line temperature.
- Always let the line temperature stabilize before testing.
- Once the air is removed, begin slowly elevating the pressure in increments up to 200-psi per minute.
- Stop and hold the pressure at each increment for 5 minutes.
- Maximum test pressure is equal to the pipe rating label.



**CAUTION:** Do not exceed the maximum rated pressure of the lowest rated component of the system.

- **Do not test at higher than rated pressure of the pipe (pipe label) without written permission from a Fiber Glass Systems Representative.**
- Typical test durations of 2 to 4 hours are typical.
- Inspect the line during the test by walking the line and visually inspecting for leakage, over bending, or evidence of damage.
- Variations in ambient temperatures will cause fluctuations in pressure over an extended test.
- Contact Fiber Glass Systems prior to any pneumatic testing.

**CAUTION:** Do not allow uncovered or uninsulated test lines filled with water to freeze since the expansion of the ice in the lines can damage the pipe.



## Locating a Leak

Locating a leak in a line may become difficult. Techniques that can be used to find leaks include:

- Walking the line and visually inspecting for leakage.
- Adding dye or odorant to the water.
- Add geophones, dye, or odor agents (use mercaptan) to the water.
- Reference Section 9 for repair methods.

# Section 8

## Fiberglass to Steel Connections

## STAR Threaded Connections

Changing over to steel pipe from STAR threaded connections can be accomplished in a variety of ways. Each changeover method has distinct advantages depending on the pressure requirement.

Options:

- Fiberglass flat faced female threaded flanges are recommended for transitioning to steel or other materials.
- Fiberglass API 8rd change-over nipples or couplings. Reference Section API 8rd Change-Overs.
- Steel API 8rd change-over nipples or couplings are available from various supply stores. Reference Section API 8rd Change-Overs.
- Super Seal x Male NPT crossover (< 500-psi).
- Super Seal x Male API 8rd (< 500-psi).
- Super Seal x Groove (< 500-psi).



**CAUTION:** Do not test above the pressure rating of the fitting.

### API 8rd Change-Overs

- **Expansion:** Due to the higher expansion rate of fiberglass versus steel, the preferred threaded change-over is a fiberglass male to steel coupling.
- **Thread Compatibility:** Fiberglass API 8rd threads are long-form type and vary with typical steel short-form 8rd threads. Reference Table 10.

### API 8rd Thread Removal

Some fiberglass 8rd long-form threads require removal (using hacksaw) for proper sealing with steel 8rd short-form connections. Most steel equipment and steel change-overs are prepared with short-form 8rd threads. The steps prior to thread removal are as follows:

1. Chase the steel connection with a steel nipple.
2. Make sure the steel threads are smooth with no burrs or sharp edges.

3. Dry fit the fiberglass to steel connection.
4. If the connection seizes up premature to full engagement, then the steel is probably short-form. Reference Table 11 for thread removal from front of the fiberglass male.

**Table 10**

STAR API 8rd Threads vs. Steel

Thread Size (in)	API Thread Specification	Thread Length	Make-Up Loss	Thread Length Diff. <sup>(3)</sup>
1.90	EUE 10rd <sup>(1)</sup>	2.36	2.06	0.50
2 3/8	EUE 8rd <sup>(1)</sup>	2.94	2.56	0.63
2 7/8		3.25	2.88	0.63
3 1/2		3.50	3.13	0.75
4 1/2		3.88	3.50	0.88
5 1/2	OD 8rd <sup>(2)</sup>	4.75	4.38	0.63
6 5/8		4.25	3.88	0.75
7		4.88	4.50	0.88
8 5/8		4.88	4.50	1.125
9 5/8		5.13	4.75	1.375

<sup>(1)</sup> API Specification Standard 5B, 16th Ed., Table 8 (L<sup>4</sup> min)<sup>-</sup>

<sup>(2)</sup> API Specification Standard 5B, 16th Ed., Table 4 (L<sup>4</sup> min)<sup>-</sup>

<sup>(3)</sup> Fiberglass threads are longer by this length.

**Table 11**

STAR API 8rd Thread Removal

Thread Size (in)	No. of Threads to Cut Off	Thread Length
1.90	6	<p>Dry fit prior to cutting off threads.</p> <p>To take full advantage of the performance of the fiberglass thread, it is good practice to have the steel threaded connection ordered to match the fiberglass long-form thread.</p>
2 3/8	5	
2 7/8	6	
3 1/2	6	
4 1/2	7	
5 1/2	5	
6 5/8	6	
7	7	
8 5/8	9	
9 5/8	11	

## STAR Flanges

### Fiberglass Flat Faced Flanges

- STAR API 8rd and Super Seal flat faced female threaded flanges are available in a variety of pressure ratings.
- Proper gaskets, spacer rings, backing plates, bolt lengths, nuts, and washers must be addressed for installation.
- Fiberglass flanges are thicker than steel flanges, therefore, the required bolt length is longer. Reference Table 13.

### Washers

- All fiberglass flanges require washers, unless a steel backing plate is used.

### Flange Gaskets

- Spiral wound gaskets are recommended for all fiberglass flanges.
- For CEN, SP, and SPH flanges, Graph-Lock gaskets (TC3125) can be used up through ANSI 600.
- Gaskets are purchased separately from flanges.

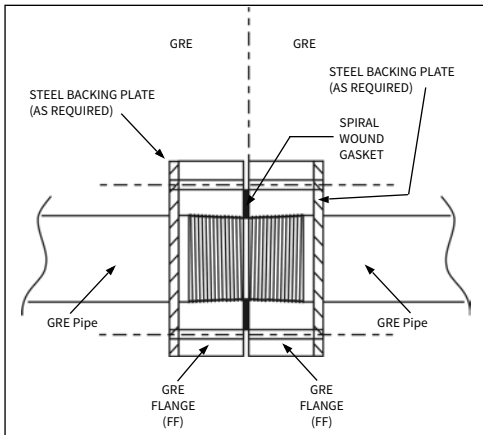
### Steel Backing Plates

- Required for higher pressure flanges. Reference Table 13 for steel backing plate requirements.
- Failure to use specified backing plates will void product warranty.
- Requires longer bolts to accommodate extra thickness, add 1/2" per steel backing plate to bolt length.

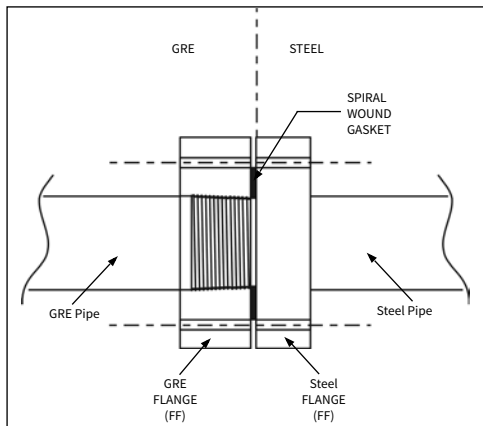
### Connecting to Raised Face Steel Flange

- Requires a special **spacer ring** or machining off raised face to avoid shearing or cracking the flange when bolts are tightened.
- Specify thickness of flange raise when ordering.
- Raised face spacer rings are required for makeup of flanges ANSI 600 and higher to steel raised face flanges.





**Figure 13 - Fiberglass to Fiberglass**



**Figure 14 - Fiberglass to Steel Flat Face**

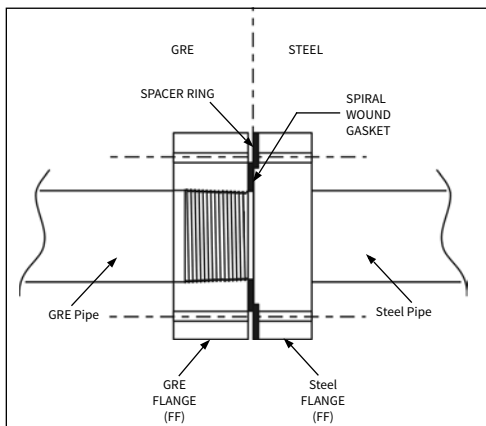


Figure 15 - Fiberglass to Steel Raised Face

## Torque Requirements

Table 12

Bolt Torque vs Bolt Size

Bolt Size (in)	Torque			
	Grade 2		Grade 5	
	ft•lb	N•m	ft•lb	N•m
5/8	54	73	89	120
3/4	96	130	160	216
7/8	155	210	258	349
1	230	311	386	523
1 1/8	324	439	544	737
1 1/4	460	623	776	1052
1 3/8	595	806	1006	1363
1 1/2	795	1077	1347	1826
1 5/8	845	1145	1100	1491
1 7/8	1565	2121	2000	2711

1. Multiply by 0.9 for plating.
2. Regardless of bolting material, do not exceed Grade 5 torque.
3. Reference Fig. 16 for bolt torque sequence recommendation

# Table 13

ANSI 150 Typical Flange Dimensions (in)

Pipe Size in	Thread Size in	Thread Type	Pressure Rating		Flange O.D. in	Flange Width in	Bolt Circle in	No. of Bolts	Bolt Hole in	Bolt Size in	Bolt Length		Wt. lbs
			100°F psi	200°F psi							FG to FG	Steel	
<b>ANSI 150</b>													
2	2 3/8	8rd	285	260	6.0	3.06	4.75	4	0.750	.625	10	5.63	4.6
2 1/2	2 7/8	8rd	285	260	7.0	3.38	5.50	4	0.750	.625	12	6.06	7.0
3	3 1/2	8rd	285	260	7.5	3.63	6.00	4	0.750	.625	10	6.38	8.1
4	4 1/2	8rd	285	260	9.0	4.00	7.50	8	0.750	.625	14	7.25	12.0
6	6 5/8	8rd	285	260	11.0	4.38	9.50	8	0.875	.75	14	7.44	17.5
6	7	8rd	285	260	11.0	5.00	9.50	8	0.875	.75	14	8.06	18.4
8	8 5/8	8rd	285	260	13.5	5.00	11.75	8	0.875	.75	14	8.44	28.5
8	9 5/8	8rd	285	260	13.5	5.25	11.75	8	0.875	.75	14	8.44	24.8
2	2	SP	285	260	6.0	4.50	4.75	4	0.750	.625	14	10.50	7.0
3	3	SP	285	260	7.5	4.50	6.00	4	0.750	.625	14	10.69	11.0
4	4	SP	285	260	9.0	4.50	7.50	8	0.750	.625	14	10.69	14.0
4	4	SPH	285	260	9.0	4.50	7.50	8	0.750	.625	14	10.69	14.0
6	6	SPH	285	260	11.0	6.00	9.50	8	0.875	.75	16	10.50	23.0
8	8	SS	285	260	13.5	5.00	11.8	8	0.875	.75	14	8.44	28.2
10	10	SS	285	260	16.0	5.80	14.3	12	1.0	.875	16	11.44	37.2
12	12	SS	285	260	19.0	6.40	17.0	12	1.0	.875	18	12.8	61.1

NOTE: When ordering valves, check the ANSI bolt pattern versus the thread size and ANSI Rating. Some high-pressure line pipe sizes require jump-size threads.

# Table 13

ANSI 300 Typical Flange Dimensions (in)

Pipe Size	Thread Size	Thread Type	Pressure Rating		Flange O.D.	Flange Width	Bolt Circle	No. of Bolts	Bolt Hole	Bolt Size	Bolt Length		Wt.
			100°F	200°F							FG to FG	Steel	
in	in		psi	psi	in	in	in		in	in			lbs
<b>ANSI 300</b>													
4	4 1/2	8rd	740	675	10.0	4.00	7.88	8	0.875	.75	14	8.00	18.5
5	5 1/2	8rd	740	675	11.0	4.88	9.25	8	0.875	.75	14	10.5	26.6
6	6 5/8	8rd	740	675	12.5	4.38	10.63	12	0.875	.75	14	8.13	25.2
6	7	8rd	740	675	12.5	5.00	10.63	12	0.875	.75	14	9.19	27.2
8	8 5/8	8rd	740	675	15.0	5.00	13.00	12	1.000	.875	14	9.19	38.7
8	9 5/8	8rd	740	675	15.0	5.25	13.00	12	1.000	.875	14	9.19	35.4
2	2	SP	740	675	6.5	4.50	5.0	8	.75	.625	14	10.63	8.0
3	3	SP	740	675	8.2	4.50	6.62	8	.875	.75	14	10.87	12.0
4	4	SP	740	675	10.0	4.50	7.88	8	.875	.75	14	11.00	19.0
4	4	SPH	740	675	10.0	4.50	7.88	8	.875	.75	14	11.00	19.0
6	6	SPH	740	675	12.5	6.00	10.62	12	.875	.75	16	10.94	34.0
8	8	SS	740	675	15.0	5.00	13.0	12	1.0	.875	14	8.44	38.3
10	10	SS	740	675	17.5	5.80	15.3	16	1.125	1.00	16	12.13	50.4
12	12	SS	740	675	20.5	6.40	17.8	16	1.25	1.125	18	13.57	77.4

NOTE: When ordering valves, check the ANSI bolt pattern versus the thread size and ANSI Rating. Some high-pressure line pipe sizes require jump-size threads.

# Table 13

ANSI 300/600 Typical Flange Dimensions (in)

Pipe Size in	Thread Size in	Thread Type	Pressure Rating		Flange O.D. in	Flange Width in	Bolt Circle in	No. of Bolts	Bolt Hole		Bolt Size in	Bolt Length <sup>(2)</sup>		Wt. lbs
			100° F psi	200° F psi					in	in		FG to FG	FG to Steel	
<b>ANSI 300/600<sup>(2)</sup></b>														
1 1/2	1.90	8rd	1480	1350	6.1	2.56	4.50	4	0.875	.75	10.0	5.69	4.3	
2	2 3/8	8rd	1480	1350	6.5	3.06	5.00	8	0.750	.625	10.0	6.06	5.3	
2 1/2	2 7/8	8rd	1480	1350	7.5	3.38	5.88	8	0.875	.75	12.0	6.75	7.6	
3	3 1/2	8rd	1480	1350	8.3	3.63	6.63	8	0.875	.75	12.0	9.62	9.7	

NOTE: When ordering valves, check the ANSI bolt pattern versus the thread size and ANSI Rating. Some high-pressure line pipe sizes require jump-size threads.

(1) Spiral wound gaskets (Flexitalic®) are required in all flange joints.

(2) Spacer rings are required for make-up of ANSI 600-1500 when mated to steel raised face flanges.

(3) Steel backing plates are required.

# Table 13

ANSI 600 Typical Flange Dimensions (in)

Pipe Size	Thread Size	Thread Type	Pressure Rating		Flange O.D.	Flange Width	Bolt Circle	No. of Bolts	Bolt Hole	Bolt Size	Bolt Length		Wt.
			100°F	200°F							FG to FG	Steel	
in	in		psi	psi	in	in	in		in	in			
<b>ANSI 600 (2)</b>													
4	4 1/2	8rd	1480	1350	10.8	4.00	8.50	8	1.000	.875	14.0	8.50	18.8
5	5 1/2	8rd	1480	1350	13.0	4.88	10.50	8	1.125	1.00	14.0	9.00	34.9
6	6 5/8	8rd	1480	1350	14.0	4.38	11.50	12	1.125	1.00	14.0	9.00	33.3
6	7	8rd	1480	1350	14.0	5.00	11.50	12	1.125	1.00	14.0	9.63	36.5
8	8 5/8	8rd	1480	1350	16.5	5.00	13.75	12	1.250	1.125	14.0	10.69	49.8
8	9 5/8	8rd	1480	1350	16.5	5.25	13.75	12	1.250	1.375	16.0	12.94	47.1
2	2	SP	1480	1350	6.5	4.5	5.0	8	.75	.625	14	10.75	8.0
3	3	SP	1480	1350	8.2	4.5	6.62	8	.875	.75	14	11.00	12.0
4	4	SP	1480	1350	10.75	4.5	8.5	8	.875	.875	14	11.25	23.0
4	4	SPH	1480	1350	10.75	4.5	8.5	8	1.0	.875	14	11.25	22.0
6	6	SPH	1480	1350	14.0	6.0	11.5	12	1.125	1.0	16	11.88	46.0
6	6	SS HP	1480	1350	14.0	9.2	11.5	12	1.125	1.0	24	16.93	69.0
8	8	SS	1480	1350	16.5	5.0	13.8	12	1.25	1.125	14	10.87	49.4
8	8	SS HP	1480	1350	16.5	9.2	13.8	12	1.25	1.125	24	17.24	88.0
10	10	SS	1480	1350	20.0	5.8	17.0	16	1.375	1.25	16	12.75	76.9
10	10	SS HP	1480	1350	20.0	9.2	17.0	16	1.375	1.25	24	17.55	123.5
12	12	SS	1480	1350	22.0	6.4	19.3	20	1.375	1.25	18	12.75	95.4
12	12	SS HP	1480	1350	22.0	9.2	19.3	20	1.375	1.25	24	17.67	138.7

NOTE: When ordering valves, check the ANSI bolt pattern versus the thread size and ANSI Rating. Some high-pressure line pipe sizes require jump-size threads.

# Table 13

ANSI 900 Typical Flange Dimensions (in)

Pipe Size in	Thread Size in	Thread Type	Pressure Rating		Flange O.D. in	Flange Width in	Bolt Circle in	No. of Bolts	Bolt Hole in	Bolt Size in	Bolt Length		Wt. lbs
			100°F psi	200°F psi							FG to FG	FG to Steel	
<b>ANSI 900 (2)</b>													
3	3 1/2	8rd	2200	2025	9.5	3.63	7.50	8	1.000	.875	12.0	9.87	13.7
4	4 1/2	8rd	2200	2025	11.5	4.00	9.25	8	1.250	1.125	14.0	9.25	21.5
5	5 1/2 (3)	8rd	2200	2025	13.8	4.88	11.00	8	1.375	1.25	16.0	12.62	38.9
6	6 5/8 (3)	8rd	2200	2025	15.0	4.38	12.50	12	1.250	1.25	14.0	10.87	39.4
6	7 (3)	8rd	2200	2025	15.0	5.00	12.50	12	1.250	1.25	16.0	12.69	43.5
8	8 5/8 (3)	8rd	2200	2025	18.5	5.00	15.50	12	1.500	1.375	16.0	13.00	75.0
8	9 5/8 (3)	8rd	2200	2025	18.5	5.25	15.50	12	1.500	1.375	16.0	12.75	64.9
2	2	SP	2220	2025	8.5	4.5	6.5	8	1.0	.875	14	11.25	15.0
3	3	SP	2220	2025	9.5	4.5	7.5	8	1.0	.875	14	11.25	18.0
4	4	SP	2220	2025	11.5	4.5	9.25	8	1.25	1.125	14	11.50	25.0
4	4	SPH	2220	2025	11.5	4.5	9.25	8	1.25	1.125	14	11.50	25.0
6	6	SPH	2220	2025	15.0	6.0	12.5	12	1.25	1.125	16	12.69	54.0
6	6	SSHP	2200	2025	15.0	9.2	12.5	12	1.25	1.125	24	17.24	82.0
8	8	SSHP	2200	2025	18.5	9.2	15.5	12	1.5	1.375	24	17.55	119.3
10	10	SSHP	2200	2025	21.5	9.2	18.5	16	1.5	1.375	24	17.80	152.1
12	12	SSHP	2200	2025	24.0	9.2	21.0	20	1.5	1.375	24	18.17	181.7

NOTE: When ordering valves, check the ANSI bolt pattern versus the thread size and ANSI Rating. Some high-pressure line pipe sizes require jump-size threads.

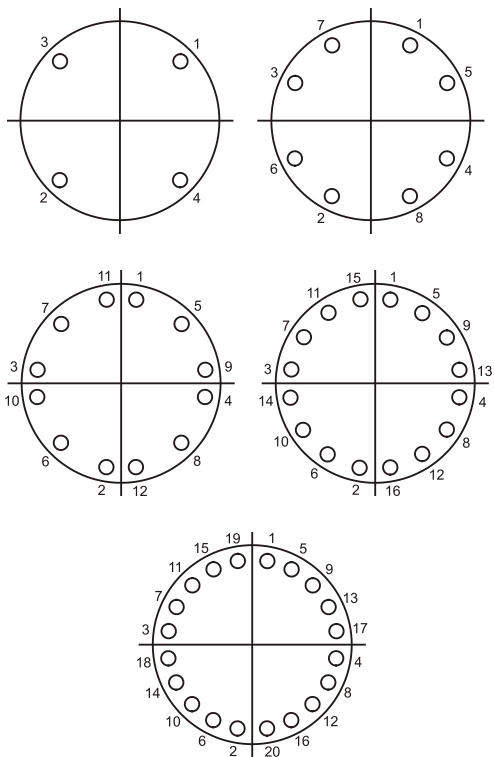
# Table 13

ANSI 900/1500 and 1500 Typical Flange Dimensions (in)

Pipe Size	Thread Size	Thread Type	Pressure Rating		Flange O.D.	Flange Width	Bolt Circle	No. of Bolts	Bolt Hole		Bolt Length		Wt.
			100°F	200°F					in	in	FG to FG	Steel	
in	in		psi	psi	in	in	in	in	in	in	in	in	
<b>ANSI 900/1500 (2)</b>													
1 1/2	1.90	8rd	3705	3375	7.0	2.56	4.88	4	1.125	1.125	10	6.56	5.6
2	2 3/8	8rd	3705	3375	8.5	3.06	6.50	8	1.000	1.125	10	7.06	9.7
2 1/2	2 7/8	8rd	3705	3375	9.6	3.38	7.50	8	1.125	1.375	12	7.75	13.6
<b>ANSI 1500 (2)</b>													
3	3 1/2	8rd	3705	3375	10.5	3.63	8.00	8	1.250	1.125	12	8.75	16.8
3	4 1/2	8rd	3705	3375	10.5	4.00	8.00	8	1.250	1.125	12	10.38	18.8
4	4 1/2 (3)	8rd	3705	3375	12.3	4.00	9.50	8	1.375	1.25	14	10.88	24.9
4	5 1/2 (3)	8rd	3705	3375	12.3	4.88	9.50	8	1.375	1.25	16	13.50	28.5
5	5 1/2 (3)	8rd	3705	3375	14.8	4.88	11.50	8	1.625	1.5	16	13.50	44.9
6	6 5/8 (3)	8rd	3705	3375	15.5	4.38	12.50	12	1.500	1.375	14	12.25	41.1
6	7 (3)	8rd	3705	3375	15.5	5.00	12.50	12	1.500	1.375	16	13.75	45.4
8	9 5/8 (3)	8rd	3705	3375	19.0	5.25	15.50	12	1.750	1.625	18	15.87	72.0
2	2	SP	3705	3375	8.5	4.5	6.5	8	1.0	.875	14	11.25	15.0
3	3	SP	3705	3375	10.5	4.5	8.0	8	1.25	1.125	14	11.63	22.0
4	4	SP	3705	3375	12.25	4.5	9.5	8	1.375	1.25	14	11.62	29.0
4	4	SPH	3705	3375	12.3	4.5	9.5	8	1.375	1.25	14	11.87	29.0
6	6	SS HP	3705	3375	15.5	9.2	12.5	12	1.5	1.375	24	18.30	86.0
6	6	SPH	3705	3375	15.5	6.0	12.5	12	1.5	1.375	18	15.25	57.0
8	8	SS HP	3705	3375	19.0	9.2	15.5	12	1.75	1.625	26	19.89	123.9
10	10	SS HP	3705	3375	23.0	9.2	19.0	12	2.0	1.875	26	20.52	179.2
12	12	SS HP	3705	3375	26.5	9.2	22.5	12	2.12	2.0	24	19.93	239.0

NOTE: When ordering valves, check the ANSI bolt pattern versus the thread size and ANSI Rating. Some high-pressure line pipe sizes require jump-size threads.





**Figure 16 - Bolt Torque Sequence**

<sup>(1)</sup> Spiral wound gaskets (Flexitalic®) are required in all flange joints.

<sup>(2)</sup> Spacer rings are required for make-up of ANSI 600-1500 when mated to steel raised face flanges.

<sup>(3)</sup> Steel backing plates are required.

# Section 9

## Field Fabrication

API 8rd Threaded Nipples  
Super Seal Threaded Nipples  
REpair Methods  
Bell x Male Adapters  
Application of STAR 8rd Field Threads

## Field Fabrication

Special length nipples are often required to locate a fitting or flange in a certain location or to make a repair.

### API 8rd Threaded Nipples

There are six methods for fabricating a nipple or spacing out of a fitting for API 8rd threaded products. Methods #1 and #2 go on the body of the pipe, not requiring upset. Methods #3 – #6 take into consideration the fact that the API 8rd thread requires an upset on the pipe body or factory nipple stock.

1. Bell x male 8rd threaded adapters applied on the pipe body. (Reference Table 14 and Table 16)
2. Field molded threads with a hand buildup on the pipe body. (Reference Table 14.)
3. Field molded threads on nipple stock. (Maintains full pressure rating of the nipple stock.)
4. Pre-fabricated factory nipples with molded threads from nipple stock.
5. Pre-fabricated factory nipples with precision ground threads from nipple stock.
6. Threads can be molded in the field on existing pipe by using the upset behind the pin thread. The upset must be long enough for new threads and width of wrench without using transition. Maintains full pressure rating of pipe.

### Super Seal Threaded Nipples

There are two methods for fabricating a nipple or spacing out of a fitting. Method #1 goes on the body of the pipe, not requiring upset. Method #2 requires a special length nipple from the factory.

1. Bell x male Super Seal threaded adapters applied on the pipe body. (Reference Table 16.)
2. Pre-fabricated factory nipples with Super Seal threads.

# Table 14

API 8rd Field Threaded Options

Thread Type	Thread Size (in) / Maximum Pressure Ratings (psi)										
	1.90	2 3/8	2 7/8	3 1/2	4 1/2	5 1/2	6 5/8	7	8 5/8	9 5/8	
<b>Bell x Male Adapter</b> <sup>(4)</sup>	2500	2500	2500	2500	2000	1500	1250	1250	1000	-	
<b>Molded Threads on Standard Nipple Stock</b>	4000	4000	3500	3000	2500	2000	1000 2000 <sup>(1)</sup>	2000 2500 <sup>(2)</sup>	2000	2000	
<b>Molded Threads on Hand Buildup</b>	2500	2500	2500	2500	2000	1250	800	1500	800	NR	
<b>Minimum Layers of Reinforcement</b>	2	2	2	2	2	2	2	2	3	-	
<b>Recommended Product Range</b> <sup>(3)</sup>	2000- 2500	2000- 2500	2000- 2500	1500- 2500	1500- 2000	1250	800	1250- 1500	500- 800	NR	

<sup>(1)</sup> Note: 5.93" ID = 1000 psi. 5.50" ID = 2000 psi.

<sup>(2)</sup> Note: 5.93" ID = 2000 psi. 5.50" ID = 2500.

<sup>(3)</sup> Lower rated products require many layers of reinforcement.

<sup>(4)</sup> Reference Table 16 for Super Seal bell x male adapters.

## Repair Methods

The repair of Star Line Pipe primarily involves the installation of a flange set. The following are the repair methods and the limitations of each method.

**NOTE:** The Fiber Glass Systems Field Service Representative should never make any cut in the line during the repair. Customer is responsible for lock-out tag-out.

### Method 1

Purchase a pre-fabricated repair joint designed to replace a full joint of pipe and allows room for a flange set. This method works for API 10rd and 8rd connections and for Super Seal connections. This is the recommended repair method.

- Determine the length of the joint to be replaced by measuring the total length of the exposed pipe.
- Purchase a pre-fabricated repair joint designed to replace the full joint of pipe and allows room for a flange set.
- Cut the damaged joint using a hacksaw.
- Remove both remaining ends using two strap wrenches.
- Replace the damaged joint with the special length repair joint.
- Install the flange set.
- Reference Figure 17 and 18.

### Star Aliphatic Amine Line Pipe (Figure 17)

- 1 pin x pin repair joint or 2 pin x pin repair joints plus a coupling
- 1 flange set

### Star Anhydride and Aromatic Amine Line Pipe (Figure 18)

- 1 pin x box repair joint
- 1 pin x pin repair joint
- 1 flange set

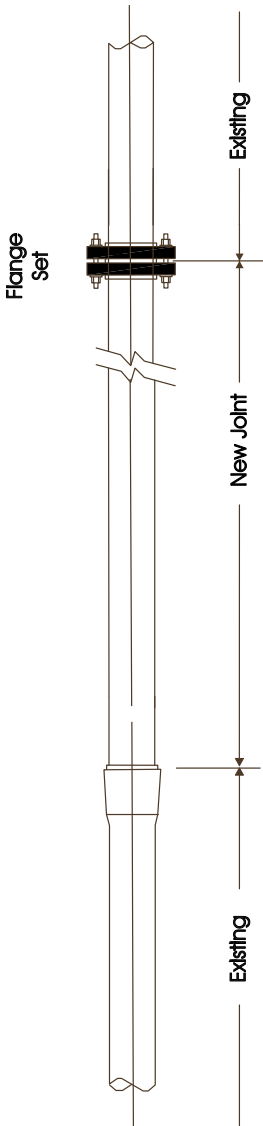


Figure 17 - Method 1 Repair Joint

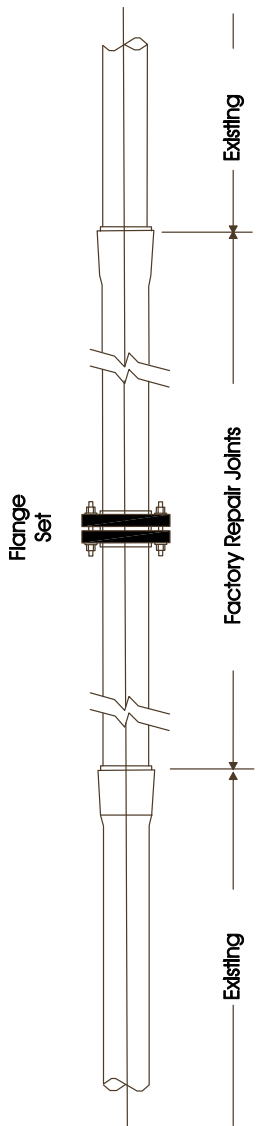


Figure 18 - Method 1 Repair Joint

## Method 2

If extra pipe is available, replace the damaged joint with a new joint which can be shortened in the field to make room for the flange set and a minimum length nipple.

- Cut the damaged joint using a hacksaw.
- Remove both remaining ends using two strap wrenches.
- Replace with a new joint of pipe.
- Shorten the joint as required to fit the flange set and a minimum length nipple.
- **API 10rd/8rd**
  - Cut the pipe on the upset only. If this is not possible, either use nipple stock or buildup the pipe body.
  - Reference Field Fabrication of Star 10rd/8rd Threaded Nipples.
  - Field thread the pipe and install the flange set.
- **Super Seal**
  - Use bell x male adapters on the pipe body.
  - Install the flange set.

**NOTE:** Some field thread options may de-rate the pressure of the line.

## Method 3

Make use of the undamaged pipe by rethreading the ends in the field allowing for the flange set. Reference Table 14 for field threading options for Star 8rd connections. Reference Table 16 for reference to Super Seal bell x male adapters. Some field thread options or bell x male adapters may de-rate the pressure of the line.

- Consider the length of the damage. If the width of a set of flanges will repair the area, a nipple (long enough to repair the damaged area) and a coupling will be required along with the flange set.

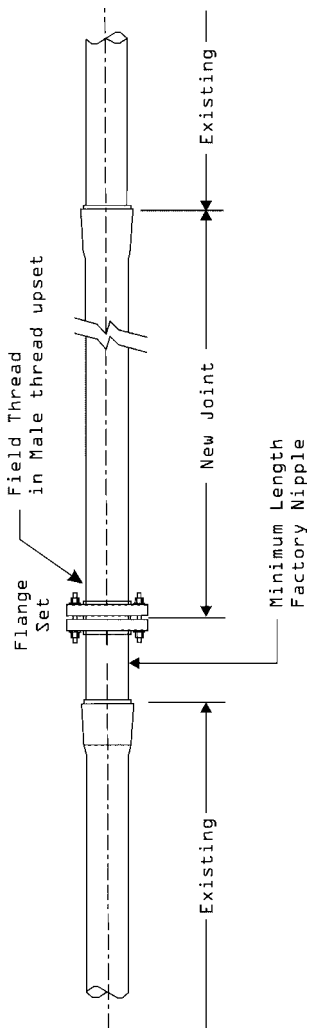


Figure 19 - Method 2 Repair Joint

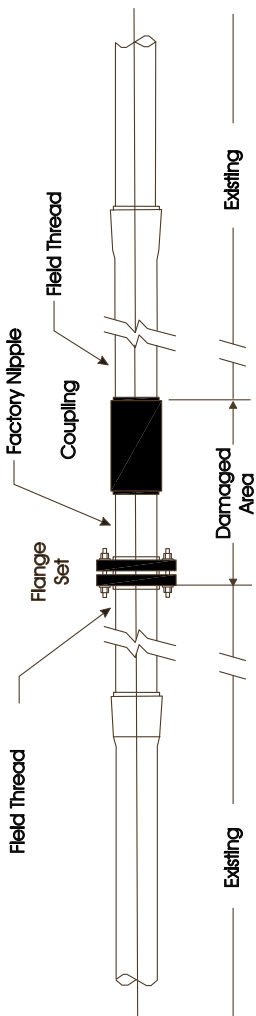


Figure 20 - Method 3 Repair Joint



- Cut out the damaged area of the pipe using a hack saw taking into consideration the total laying length of the parts needed to make the repair.
- Depending on how long the damaged area is, an extra joint of pipe may be required.
- Rethread both square cut ends using procedures in the Field Fabrication of Pipe Upset section for field threads or bell x male adapters.
- Install the flange set.

### Option for Low Pressure Repair – CEN Connections

Bonded Flanges, Bell x Bell Sleeve Couplings, and Bell x Groove Adapters.

- Bell x groove adapters usually de-rate the line to 125 psi.
- Requires Star approved tapering tool set at 1-3/4° taper angle.
- Follow bonding procedures in the bonded threaded adapters section and in INS1000 (Installation Guide for Matched Tapered Bell x Spigot Joints).
- Limited pressure ratings which depend on the type of fitting that is used to make the repair.

Bonded Saddle Patch

- Bonded saddle patches are not considered permanent repairs and they cannot be applied over a wet surface.
- Table 15 shows the maximum pressure that a bonded saddle should be attempted.

**Table 15**

Max Pressure for Bonded Saddle Patches

Pipe Size (in)	1 ½ - 2	2 ½ - 3
Maximum Pressure Rating (psi)	450	300

- Patch length – A length of good pipe is cut and split longitudinally for 180° of circumferential coverage and long enough to cover the damaged area plus 1 foot on each side.
- Sand the area to be patched and the interior of the saddle with 40 grit sand paper; remove all the gloss or shine.
- Sanded areas must be thoroughly cleaned of all foreign material, oils, grease, and fingerprints. If cleaning solvent is used, the surfaces must be thoroughly dried.
- Use a heavy coat of epoxy adhesive on both surfaces.
- Snap the patch in place over the damaged area.
- During curing hold the patch in place with several hose clamps, spaced 6” (152 mm) along the patch.
- Do not pressurize until fully cured. Check the hardness with a knife blade.
- Leave the patch visible for inspection during pressure test.

## Bell x Male Threaded Adapters

### Selection of Bell x Male Adapters

- Select the proper bell x male adapter by thread size and pressure rating as shown in Table 16.
- To order bell x male adapters, use the codes in Table 16.

**Table 16**

8rd Bell x Male Threaded Adapter Codes

Thread Size	Pressure Rating	Anhydride		Aliphatic Amine		Aromatic Amine
		STD	15HR	STD	15HR	15HR
1.90	1250	N/A	R	N/A	N/A	N/A
	1500	R	R	R	R	R
	1750	R	R	R	R	Q
	2000	R	Q	R	R	Q
	2250	R	Q	R	Q	S
	2500	Q	S	R	P	N/A

**Table 16** (continued)

8rd Bell x Male Threaded Adapter Codes

Thread Size	Pressure Rating	Anhydride		Aliphatic Amine		Aromatic Amine
		STD	15HR	STD	15HR	15HR
2 3/8	750	N/A	S	N/A	R	N/A
	800	N/A	N/A	R	N/A	N/A
	1000	N/A	S	R	R	S
	1250	S	S	R	R	S
	1500	S	S	R	R	S
	1750	S	S	R	S	Q
	2000	S	Q	R	Q	P
	2250	Q	P	R	P	N/A
	2500	Q	P	S	N/A	Q
2 7/8	750	N/A	T	N/A	U	T
	800	N/A	N/A	U	N/A	N/A
	1000	T	T	U	U	T
	1250	T	T	U	U	T
	1500	T	T	U	T	Q
	1750	T	S	U	S	Q
	2000	S	Q	U	Q	N/A
	2250	Q	Q	T	Q	N/A
	2500	Q	N/A	R	Q	Q
3 1/2	500	N/A	T	U	U	T
	750	N/A	T	N/A	U	T
	800	T	N/A	U	N/A	N/A
	1000	T	T	U	U	T
	1250	T	T	U	U	S
	1500	T	S	U	S	S
	1750	T	S	U	S	Q
	2000	S	R	S	R	P
	2250	S	Q	S	R	S
	2500	R	P	R	Q	S

**Table 16** (continued)

8rd Bell x Male Threaded Adapter Codes

Thread Size	Pressure Rating	Anhy		Aliph		Aromatic Amine
		STD	15HR	STD	15HR	15HR
4 1/2	500	T	T	U	U	T
	750	N/A	T	N/A	U	T
	800	T	N/A	U	N/A	N/A
	1000	T	T	U	U	S
	1250	T	S	U	T	R
	1500	S	R	T	R	Q
	1750	S	R	S	Q	P
	2000	R	P	R	P	Q
TC5 1/2	500	R	R	R	N/A	N/A
	750	N/A	R	N/A	N/A	R
	800	R	N/A	R	N/A	N/A
	1000	R	R	R	N/A	Q
	1250	R	Q	R	N/A	P
	1500	Q	P	T	N/A	N/A
6 5/8*	500	V	V	S	S	V
	750*	N/A	V	N/A	U <sup>(1)</sup>	S
	750*			N/A	S <sup>(2)</sup>	
	800*	V	N/A	U <sup>(1)</sup>	N/A	N/A
	800*			S <sup>(2)</sup>		
	1000*	V	S	U <sup>(1)</sup>	T <sup>(1)</sup>	Q
	1000*			R <sup>(2)</sup>	R <sup>(2)</sup>	
	1250	S	Q	T	N/A	V
8 5/8	500	U	U	S	S	U
	750	N/A	U	N/A	R	T
	800	U	N/A	S	N/A	N/A
	1000	T	S	R	N/A	R

\* Important Notice - It is important to know the ID before ordering 6 5/8" Threaded Adapters.

<sup>(1)</sup> 5.50 ID

<sup>(2)</sup> 5.93 ID

## Table 17

O-ring Bell x Male Threaded Adapter Codes

<b>Pipe Size</b>	<b>Thread Type</b>	<b>Pressure Rating</b>	<b>Aliphatic Amine</b>
<b>in</b>		<b>psi</b>	
8	SS	500	R
10	SS	500	R
12	SS	500	R

## Application of Star 8rd Field Threads

### Required Tools and Accessories

- Hack saw or circular saw equipped with carbide blade.
- Conventional tapering tool capable of making a  $1\ 3/4^\circ$  taper (1" increase of OD in 16" of length or 1 to 16 ratio).
  - Unique Tapering Tool – Model 010 (2" – 6")
  - Unique Grinding Tool – Model 10-612 (2" – 12")
- Epoxy kit and rubber gloves.
- Electric heat collar, propane torch or chemical heat pack.

### Preparation

- Calculate the length of the nipple by subtracting the laying length (center to center) of the fittings to be assembled and adding the insertion depths (see Fittings Data Sheet) of the nipple.
- Add adhesive lubricating factor to the nipple of 1/8" to 1/4" for each taper to be bonded to the nipple length previously calculated.
- Mark the pipe with a wrap around.
- Cut the pipe with a saw.
- Apply a  $1\ 3/4^\circ$  taper with tapering tool.
- Avoid over tapering the end of the nipple.

### Example:

Measured Distance	-	Fittings Laying Lengths	+	Taper Insertion Depths	+	Adhesive Lubricating Factors	=	Nipple Length To Cut
-------------------	---	-------------------------	---	------------------------	---	------------------------------	---	----------------------

## Taper Tool Model 010 / Model 10-612

- Collets – (be sure to select the correct collets)
  - Other than 2” – mount collets on tool before sliding collets into pipe.
  - Slide tool into pipe until pipe and the collets are flush, collets contracted.
  - Expand collets in the pipe by turning torque knob clockwise.
  - Hand tight for thin wall pipe.
  - Hand tight – plus 1/4 turn with wrench for thick wall pipe.

**NOTE:** Reference the Tapering Tool’s product brochure for a complete overview of tapering instructions.



### **CAUTION:**

1. For all cutting and tapering, the pipe must be held securely.
2. End of the pipe must be as straight as possible to ensure proper insertion length.

## Cutting the Taper Operation

- A. For cutting a taper, the tool must be turning clockwise – feed the head down slowly every few turns by turning hex head bolt clockwise.
- B. Continue turning the tool and lowering the head alternately until the taper length is reached.
- C. Rotate the tapering tool until tool stops cutting to eliminate any cutting ridge formed by the cutting blade.
- D. Loosen hex head bolt by turning counter clockwise before loosening torque knob to contract collets and removing the tool from the pipe.

**NOTE:** Cut a test taper, checking fitting to taper. The fit should be snug without clearance.

## Bell x Male Adapter Bonding Procedure

- **Environment**
  - The pipe surface temperature during bonding should be 65°F to 100°F (18.3°C to 37.8°C). At higher temperatures, shade connection from direct sunlight (make sure adhesive is “cool” when applied).
  - The bonding surface must be completely dry.
  - Humidity during bonding must be addressed; bonding is not recommended on wet surfaces.
  - Work areas must be protected against blowing sand or dust.
- **Surface Bonding Preparation**
  - The joining surfaces must be visually examined for cleanliness, damage, and UV degradation.
  - UV degradation is detected by sanding and looking for color changes or loose fibers.
  - Refinishing by sanding or re-tapering is required if UV degradation is detected.
  - Rewarming of the bonding surfaces if the temperature falls below 65°F (18.3°C).
- **Joint Cleaning**
  - Solvents can be used to remove grease, oil, mud or fingerprints; however, the surfaces must be completely dry before bonding can proceed after solvent has dried.
  - All prepared surfaces must be lightly sanded prior to applying adhesive.
- **Adhesive mixing**
  - Always wear rubber gloves.
  - Stir the epoxy contents of the can with mixing stick to ensure mixture of settled material. Particular attention to stirring is required for kits which have been stored more than 6 months. The adhesive should be smooth and free of lumps.



- Warm the epoxy by heating the can if the temperature is below 80°F (26.6°C).
- Pour the entire contents of the pre-measured amine hardener vial into the epoxy can.
- Do not attempt to split a kit.
- Cut the amine hardener into the epoxy using a mixing stick.
- Care must be taken so that the amine hardener is not spilled (affecting the mixture).
- Scrape the inside of the can to ensure that all epoxy is mixed. Mixing should take at least 2 to 3 minutes.
- The working time (pot life) for thoroughly mixed adhesive varies from 30 minutes at 70°F (21.1°C) to 10 minutes at 100°F to 120°F (37.8°C to 48.9°C).
- **DO NOT USE THE MIXED ADHESIVE IF IT IS TOO HOT TO TOUCH.**

**NOTE:** CAB-O-SIL (WHITE POWDER) IS SUPPLIED WITH EACH ADHESIVE KIT. DO NOT USE CAB-O-SIL TO THICKEN THE ADHESIVE FOR BONDED JOINTS. CAB-O-SIL IS ONLY USED FOR FIELD MOLDING 8RD THREADS.

- **Joint Assembly**

- The joints must be axially aligned.
- Bonding surfaces must be at the appropriate bonding temperature (65°F to 100°F, 18.8°C to 37.8°C).
- Bonding surfaces should never be touched by fingers or tools after cleaning.
- Apply a thin layer of mixed adhesive, normally with a clean brush, onto the bell end of the adapter first, then the male end of pipe.
- The adhesive coat should be 3 to 10 mils (excessive adhesive may interfere with obtaining a locked position)
- Slowly stab the tapered male end into the bell end of the adapter.

- Push and turn the male connection to the right until full engagement is felt.
- Wipe off excessive adhesive with disposable towels.
- Use of a block of wood and a hammer may be required to achieve full lock up.
- **Heat-Assisted Curing**
  - The adhesive bonded connection must be heat cured if the temperature is below 70°F (21°C).
  - The adhesive will set up in 24 hours at temperatures above 75°F (24°C)
  - Electric heat collars or chemical cure packs are available that generate 250°F (121°C) for a minimum of 30 minutes.
  - Heat assisted curing ensures that the connection has reached its full chemical and physical properties.
  - Use a propane torch to assist curing a bell x male adapter if a steel coupling can be screwed onto the adapter. Only apply the propane flame to the body of the steel coupling to heat the joint. Direct application of the flame to the fiberglass adhesive will damage the material.
- **Examination / Documentation**
  - Each joint must be visually inspected and documented.
  - Number each connection made and add initials of person responsible.
  - Keeping an inspection sheet per API 15TL4, Appendix C is good practice.

## **Field Molded Thread Procedure**

Prior to beginning the process of making a thread the pipe must be qualified to the diameter of the thread mold. If the pipe is not large enough to accept the full thread, either nipple stock must be purchased or a field upset must be fabricated to obtain product pressure rating as listed in Table 14. Hand buildups may de-rate the line.

- **Additional Tools and Accessories**
  - Steel thread mold (STAR).
  - Mold release agent (Trewax®) and application brush.
  - Epoxy thread paste kit.
  - Strap Wrench.
- **Environment**
  - Pipe surface temperature of 65°F (18.3°C) to 80°F (26.6°C). Warm the connection if below 65°F (18.3°C).
  - Thread surface shall be clean and completely dry.
  - Protect surface from blowing sand and dust.
- **Pipe Preparation**
  - Square cut the pipe to the proper length using a hacksaw or cut off saw with carbide blade, taking into consideration the laying length of the fittings and the insertion depth of the thread.
  - Taper the pipe using a conventional tapering tool with a 1-3/4° taper.
  - The taper should cover the entire length of the mold and 1/8” of the pipe should stick through the mold.
  - Verify the mold fit to the taper; it should be snug with no movement.
  - Make sure all oil, grease, mud, fingerprints, and sand are removed with sand paper before bonding.
  - Once cleaned, the bonding area should not be touched.
- **Mold Preparation**
  - Clean and warm factory supplied and approved thread molds to touch (100°F to 130°F (37.8°C to 54.4°C)).
  - An even, smooth coat of release agent should be applied uniformly with a soft brush to the threads and both mold faces.
  - Excess releasing agent must be removed. There should be no visual signs of release agent.

- **Thread Paste Preparation**

- Always wear rubber gloves.
- Stir the epoxy contents of the can with the mixing stick to ensure mixture of settled material. Particular attention to stirring is required for kits which have been stored more than 6 months. Adhesive should be smooth and free of lumps.
- Warm the epoxy by heating the can if the temperature is below 65°F (18.3°C).
- Pour the entire contents of the pre-measured amine hardener vial into the epoxy can.
- Do not attempt to split a kit.
- Cut the amine hardener into the epoxy using the mixing stick.
- Care must be taken so that the amine hardener is not spilled (affecting the mixture).
- Scrape the inside of the can to ensure that all epoxy is mixed (mixing should take at least 2 to 3 minutes).
- The working time (pot life) for thoroughly mixed adhesive varies from 30 minutes at 70°F (21.1°C) to 10 minutes at 100°F to 120°F (37.8°C to 48.9°C).
- **DO NOT USE THE MIXED ADHESIVE IF IT IS TOO HOT TO TOUCH.**
- Depending on the thread paste temperature, adjust the paste viscosity with CAB-O-SIL (white powdery substance) provided with the epoxy kit.
- The consistency of the paste should adhere to the mixing stick.
- Make sure the CAB-O-SIL is thoroughly mixed into the adhesive.

- **Threading**

- Fill the thread mold with the mixed thread paste using the mixing stick.

- Force the paste into the thread cavity by moving it along the thread, in one direction, from the small end of the mold to the large.
  - Cover the full surface of the thread. Break or remove any air pockets present in the thread.
  - Cover the tapered end of the pipe with approximately 1/8" of mixed epoxy paste.
  - Roll the paste around the tapered area in a fashion which assists breaking any air pockets that are present.
  - Build a 1/4" thick bead of paste around the small end of the taper.
  - Using a stabbing motion, insert the large end of the thread mold onto the tapered pipe. Push the mold on in a straight, smooth fashion.
  - Once the surfaces touch, turn the mold clockwise until the mold is locked onto the tapered surface.
  - Thoroughly clean the excess epoxy paste from the front and rear of the mold. Excessive thread paste left on the mold will cause difficult torque requirements for mold removal.
- **Heat Assisted Curing**
    - Complete cure requires 24 hours at 75°F (23.9°C).
    - Faster cure time and optimum chemical and physical performance requires the application of heat. See Table 17.
    - Thread cure can be checked at the back of the mold with a knife blade.
    - The thread must resist puncture.
  - **Mold Removal**
    - Tap the mold lightly all the way around using a small hammer.
    - Unscrew the mold using a strap wrench; avoid using a pipe wrench since this type wrench can damage the mold.

- Support the pipe during the mold removal such that it does not become bent due to torque of mold removal.
- Using a metal friction wrench or a 360° padded vise for backup during mold removal is good practice.

- **Thread Inspection**

- A fully cured thread should be shiny in appearance and substantially free of voids.
- Check the thread hardness using a center punch on the back of the threads.
- Full quality inspection requires reference to thread visual inspection standards.



Pre-heat thread mold



Apply mold release agent



Mix thread paste



Apply paste to mold



Apply paste to pipe



Stab mold onto pipe



Clean excess paste from mold



Tap mold lightly



Unscrew mold



Inspect thread

## Table 18

### Field Thread Cure

Cure Methods	Required Steps
Electric Heat Collars	250°F (121.1°C) for 30 minutes. Do not overlap. Insulate in cold weather.
Propane Torch	Contact FGS.
Chemical Heat Blanket	Follow manufacturer's instructions. Caution: Wear respirators and avoid breathing fumes. Insulate in cold weather.

## Field Fabrication of Pipe Buildup

The first step is to check the fit of the pin mold on the pipe. This is performed by sliding the pin mold onto the pipe. If the mold does not slide completely on the pipe, a good fit does not exist. Pipe surface must be sanded with an Emery cloth to prepare the

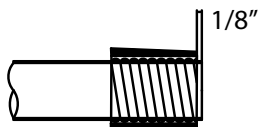
surface for the buildup of the pin. The pin buildup consists of a special woven roving reinforcement and resin lay up on the pin to form the threads. A step-by-step procedure follows.

- Cut pipe square and to length.
- Check pin mold fit.
  - Good fit if it slides on completely.
  - Poor fit if it does not completely slide onto the pipe.
  - If poor fit exists, the pipe surface must be sanded to allow the mold to completely slide onto the pipe. A slight tapering of the pipe surface is preferred and will make it easier to slide the mold into position and to squeeze excess resin out of the mold.
- The surface must be smoothed for pin buildup by sanding with an Emery cloth. The glossy layer on the pipe surface must be completely removed to provide a good bonding surface. Failure to remove all glossy material will result in a poor thread performance. This bonding surface must be clean and free of any contamination by oil or other foreign material.
- The epoxy adhesive must be mixed per the instructions for Adhesive Mixing found in the Bell x Male Adapter Bonding Procedure. The supplied CAB-O-SIL filler must be used for adhesive viscosity control.
- The viscosity must be high enough to prevent the resin from running or leaking out of the mold during setup.
- The woven roving glass strips must be thoroughly saturated with epoxy thread paste. This glass will be on a roll 2 to 4 inches wide depending on the pin diameter.
- The saturated glass must be carefully laid up by wrapping around the prepared end of the pipe. Care should be taken not to contaminate the saturated glass with foreign matter during this process.
- The number of wraps of woven roving required is dependent on the size difference in the pipe outside diameter and the diameter of the required upset for the thread. Specific data is provided in Table 14.

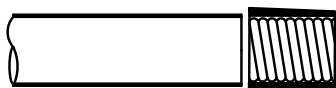


- Once the buildup is large enough, the normal field threading procedure can be followed over the wet uncured upset.

**NOTE:** This method has shown satisfactory results; however, it requires an expert competence level obtained only by special training and experience. Training by FGS Technical Service Representative is required.



Good fit



Pipe is too large,  
must be sanded.

Notes: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



## **Fiber Glass Systems**

17115 San Pedro Avenue, Ste 200  
San Antonio, Texas 78232 USA  
Phone: 210 477 7500 | Fax: 210 477 7560

National Oilwell Varco has produced this brochure for general information only, and it is not intended for design purposes. Although every effort has been made to maintain the accuracy and reliability of its contents, National Oilwell Varco in no way assumes responsibility for liability for any loss, damage or injury resulting from the use of information and data herein nor is any warranty expressed or implied. Always cross-reference the bulletin date with the most current version listed at the web site noted in this literature.

© 2019 National Oilwell Varco All Rights Reserved  
INS8000ENG November 2019

---

## **Fiber Glass Systems**



**Completion &  
Production Solutions**

[nov.com/fgs](http://nov.com/fgs)