STAR Installation and Application Practices Downhole Tubing & Casing

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NOV Fiber Glass Systems

NOV FIBER GLASS SYSTEMS PIPE INSTALLATION HANDBOOK

1. It is the End Users/Contractors/Customers responsibility to read and understand all engineering and installation related manuals and guides for the product to be installed.

2. Fiber Glass Systems, L.P. does not warranty the installation of the goods nor shall it be responsible for the performance or workmanship of any person or entity engaged in the installation or installation supervision.

3. It is strongly recommended all installers be properly trained. Fiber Glass Systems offers several types of certification training classes and/or installation job startups.

4. Fiber Glass Systems recommends a pre-installation start up meeting with the Distributor and/or Regional Manager and/or Field Service Representative 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 start up and/or certification training by a certified FGS Field Service representative.

5. Fiber Glass Systems strongly recommends early hydro testing to ensure the reliability of the field workmanship. Testing is recommended at the following points of the installation:
   - High pressure line pipe – 5000' maximum
   - Low pressure long straight runs of pipe – 2500' maximum
   - Fitting Intensive piping projects – 50 joints maximum.

6. It is the End Users/Contractors/Customers responsibility to read and understand the Field Service Policy as it relates to on-site training and/or certification.

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INTRODUCTION

There are special techniques used to properly install glass reinforced epoxy (GRE) tubulars. During the installation, NOV Fiber Glass Systems recommends that a company-trained field service representative be on site for the purpose of training the installation crew and inspection of delivered product.

Downhole products may carry hazardous material and/or operate at elevated pressures. The instructions in this manual must be followed to avoid serious personal injury or property damage. Improper installation can cause injury or damage. Installers should read and follow all cautions and warnings and observe general safety practices with all tools to avoid personal injury. Wear protective clothing when necessary. Make sure work surfaces are clean and stable and that work areas are properly ventilated.

Prior to Starting an installation, several parameters must be defined:

- Type of service
- Review STARWell analysis before product is installed
- Type of joining system
- Required fittings, pup joints, landing subs, threaded crossovers, etc.
- Correct elevators and slips for product being run.
- Acquire proper tools, make-up wrenches, select lubricant/sealant and accessories.
- Check the effect of make-up thread loss on the quantity of product ordered (Table 4.4)

Pre-Bid / Installation Meeting

- Review handling and storage
- Review installation procedures
- Qualify equipment (power tongs, hand tools, etc.)

Responsibility of the Attending NOV Fiber Glass Systems Service Representative

- Train and advise the supervisor and crew members in recommended practices
- Any new or substitute crew member and supervisor must be trained prior to taking over activities. At a minimum, two experienced and qualified crew members and a supervisor must be on location. Their qualification must be in according to the procedures in this manual.

Note: NOV Fiber Glass Systems 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.

SECTION 2

2.0 Transportation

Domestic U.S.A. or Inland Shipments require:

- Dedicated (GRE Only) 34 ft. to 40 ft. flat bed or drop deck trailers (oilfield hauler).
- Do not hang product off the trailer.
- Transporting the product on racks above a small truck (headaching) can cause potential impact damage and is prohibited.
- Use nylon straps for tie downs, do not use chains.
- Tie downs should be located near the dunnage, 4 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 can not be transported inland require the product to be crated at 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 both available.

2.1 Load Inspection

On arrival the shipment should be inspected as follows:

- Check quantities, report deviations.
- Check for load shifting, check for missing dunnage.
- Look for excessive bending caused by over-tightening of straps.
- Check for missing thread protectors and thread damage, replacement protectors can be purchased.
- Look for impact damage (blister caused by abrasion or blow with a sharp object).
- Quarantine or mark joints which appear damaged, do not install damaged product. Contact your local distributor/agent or NOV Fiber Glass Systems representative.
- Receiving party is responsible for noting shipping damage and contacting carrier. Make photos of any suspected damage or load conditions.

2.2 Unloading

Common practices include:

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

2.3 Storage

- Set the product on a surface free of rocks.
- Leave the separator boards between the product layers.
- If pipe racks are used, strip them with lumber to protect the product from sharp edges.
- Use four racks equally spaced to avoid permanent bending particularly for long-term storage.
- Storage for one year or more requires coverage with a tarp to avoid UV discoloration.
- Thread protection must remain in place to avoid UV degradation, damage, or contamination of threads.

2.4 Ultraviolet Effects on the Product Body
Ultraviolet effects on the product body are limited to surface discoloration. Eventually, fiber blooming or fuzzing will occur if the product is left exposed for long periods; the degradation is limited to the outer 0.005-0.01 inch (0.13-0.25 mm) of the product. (Table 2.1)

GRE product may be protected from the ultraviolet rays by painting with a heavily pigmented industrial coating or by coating with an ultraviolet absorbing agent. The surface effect of ultraviolet is minimal and does not reduce the long-term performance of these products.

2.5 Reshipping
Necessary precautions include:

- Loose product must be loaded with the joints staggered.
- Separate each layer of product with wooden dunnage.
- Always use nylon straps to tie down pipe, never use chains.
- Do not drop the product off the truck.
- Do not store directly on the ground and avoid contact with rocks.
- Place uprights on the trailer to keep the product from falling off the trailer.
- Do not remove thread protectors prior to installation.

Table 2.1 Ultraviolet Effects on GRE Product

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

SECTION 3

Introduction
Many standard oilfield installation techniques are used to install fiberglass tubing and casing. During the installation, a NOV Fiber Glass Systems field service representative should be on site for the purpose of training the installation crew.

3.1 STARWell

Complete well analysis service is offered and recommended by NOV Fiber Glass Systems. The STARWell Computer Program is designed specifically for fiberglass composite tubular. This program will evaluate load generated by the following variables:

- Tubing weight
- Static level differential with annulus fluid level
- Internal pressure or annulus pressure
- Changes in temperature
- Differential in fluid density inside the tubing compared to the annulus

Worst case conditions are used in calculations when well conditions are not known. If desired, a variety of conditions can be run to compare the sensitivity of change to the normal well conditions for product selection.

STARWell forms must be completed prior to installation. Copies of the well analysis can be obtained from your NOV Fiber Glass Systems sales representative.

3.2 Well Completion Considerations

Introduction: The type of application and the completion of the well can affect the well evaluation. General guidelines for the application of fiberglass tubing/casing include the following:

3.2.1 Packer Selection

- Star tubing is designed to be set in tension and never in compression. (See Stretch Chart ,Table 3.7.1a)
- Double grip packers are preferred with an on/off tool seal assembly, ¼ turn release.
- Direct tension set packers should never be used due to the potential elongation of fiberglass.
- Packers should be set using either a steel work string or a wire line. Both options require this use of an on/off tool.
- Hydraulic set packers should not be used.
- Polished bore receptacles are used with proper precautions to avoid compression. A complete STARWell evaluation must be run to determine the proper set-up.
- Temporary compression during the on-off tool latching is permitted.

3.2.2 Cementing

- Cementing in two stages may help avoid exceeding collapse rating.
- Keep differential pressure below external and internal ratings at all times.
- Avoid shock collapse pressure when seating wiper plug.
- STARWell can be used to simulate cementing conditions.

3.2.3 Rod Pump Wells

- Tubing must be anchored.
- Rod guides must be used.

3.2.4 Electrical Submersible Pumps

- Care must be given to direction and amount of start-up torque.
- Anchoring the pump to the casing is the preferred practice.
- Soft-start motors can be substituted as an alternative to anchoring.
- Since the connection diameter of fiberglass is not the same as steel, the cable size must be evaluated.

3.2.5 Landing Sub

- An alloy or stainless steel landing sub is recommended.

3.2.6 Blowout Preventers (BOPs)

- Recommended practice is to close BOPs on temporary steel rather than fiberglass.
- Laboratory tests have shown that BOPs will close successfully on fiberglass tubulars but could damage the joint and it needs to be replaced.
- Use lowest possible pressure for rams when setting on fiberglass.
- Close rams only on tubing body.
- Annular type BOPs are recommended and will not damage fiberglass tubing.

3.2.7 Annular Testing

- Annular testing should be based on the licensing authority or end-user requirements.
- Care should be exercised not to exceed product design limitations.

3.2.8 Tubing Isolation Test

- We recommend the placement of a seating nipple above the packer.
- Always drop a standing valve to the seating nipple and test the tubing internally prior to pulling the string if the tubing is suspected of leaking.
- Do not rely on annulus tests to qualify a leak in tubing.

3.3 Preparation Before Running Tubing and Casing

- Elevator selection
- Slip selection
- Proper tools, wrenches and lubricant
- Ensure metal changeover connections are compatible.
- A full set of collars and pup joints (2', 4', 6', 8', 10' and 1' if available) is required for spacing out tubing to proper tension.

3.3.1 Elevator Selection for Threaded and Coupled products

Given the fiberglass tubing/casing size and pressure rating, the table below should be used to determine elevator size. Use a slip or shoulder latch elevator type for threaded and coupled products.

Table 3.3.1

Nominal Tubing Size in	Elevator Size for Pressure Rating							
	1000 psi	1500 psi	1750 psi	2000 psi	2500 psi	3000 psi	3500 psi	4000 psi
1.90	---	---	---	2 3/8	2 3/8	2 3/8	2 7/8	2 7/8
2 3/8	2 7/8	2 7/8	2 7/8	2 7/8	2 7/8	2 7/8	3 1/2	3 1/2
2 7/8	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	4 1/2
3 1/2	4	4	4	4	4	4	5 1/2	5 1/2
4	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	5 1/2	5 1/2
4 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	6	6	6
5 1/2	---	6	---	6	6	---	---	---
7	---	8 1/4	---	8 1/4	8 1/4	---	---	---
9 5/8	---	10 3/4	---	10 3/4	10 3/4	---	---	---

3.3.2 Elevator Selection for Integral Joint products

Given the fiberglass tubing/casing size and pressure rating, the table below should be used to determine elevator size. Use a slip or shoulder latch elevator type for integral joint products.

3.3.3 Elevator Model for either Integral Joint or Threaded and Coupled product

Select the slip type elevator model per the table below.

Table 3.3.3a

Size	Joint	Elevator Model
1½" 2 ⅜", 2 ⅞"	Integral Joint	MYT
3 ½" or 4 ½"	**Integral Joint**	**YT**
5 ½" or larger	Threaded and Coupled or Integral Joint	YC

3.3.4 Slip Selection
The table below can be used for slip selection:

Caution: If string weight exceeds 20,000 lbs., discontinue use of slips and use two sets of elevators. One elevator will replace slips to support fiberglass while other set is used to pick up and lower the next joint.

Table 3.3.4a

Tubing / Casing Size	Slips
1½" - 4½"	Standard Air Slips.
≥ 5½"	Manual Bowl & Slips.

3.3.5 Wrench Selection
Sizes ≤ 4½" should be made up with strap wrenches; other wrenches must be approved by NOV Fiber Glass Systems representative.

Sizes ≥ 4½" and above may be made up by power tongs, although the initial make-up is accomplished by hand with a small strap wrench.

The power tongs should be equipped with accurate torque measuring equipment.

Caution: Over-tightening joints will make breakout difficult and may damage connection.

3.3.6 Thread Lubricant
STARtec™ must be applied to pin and box threads with a brush prior to make-up.

3.3.7 Crossovers To Steel Connections

When preparing for a crossover the following must be addressed:

- Thread compatibility.
- Trimming fiberglass threads for steel connection make-up if necessary. (See table 3.3.8a)
- Fiberglass tubing requires crossovers to steel to be installed with STARtec Lubricant.

Important: Due to the difference in expansion rate of fiberglass, compared to steel, always install a fiberglass pin thread into a steel box.

3.3.8 Cutting Threads

Some fiberglass threads may require removal (using a hacksaw) for proper sealing with steel connections. Remove the threads with a hacksaw and round the sharp edges on the end with a file. Most steel equipment uses short form threads. **Steps to qualify thread removal are:**

- Chase the steel connection with a steel nipple.
- Dry fit the fiberglass to steel connection.
- If the connection seizes up premature to full engagement, then it is probably short form and you must use the table below for thread removal.

Table 3.3.8a

Fiberglass Long Form Threads To Remove			
API EUE in	Maximum Number of Threads to Cut Off	Long Form to Short Form Thread Length Difference*	**Note**: In order to take full advantage of the performance of the fiberglass thread, it is good practice to have the metal equipment ordered in long form to match the **fiberglass long form thread**. * Per API 5B 8rd
1.90	6	.500	
2 3/8	5	.625	
2 7/8	6	.625	
3 1/2	6	.750	
4	6	.875	
4 1/2	7	.875	
5 1/2	5	.625	
7	7	.875	
8 5/8	9	1.125	
9 5/8	11	1.375	

Table 3.3.7b Fiberglass thread loss due to Make-Up

Casing and Tubing in	API Thread Specification	Thread Length in	Make-Up Loss in
1.90	EUE 10rd API 5B*	2.36	2.11
2 3⁄8	EUE 8rd API 5B*	2.94	2.69
2 7⁄8		3.25	3.00
3 1⁄2		3.50	3.25
4		4.00	3.75
4 1⁄2		3.88	3.63
5 1⁄2	OD 8rd API 5B**	4.75	4.50
6 5⁄8		4.25	4.00
7		4.88	4.63
8 5⁄8		4.85	4.60
9 5⁄8		5.13	4.88

* API Specification Standard 5B Fourteenth Edition, August 1996 - Table 14 (L4 min)
** API Specification Standard 5B Fourteenth Edition, August 1996 - Table 7 (L4 min)

3.3.9 Rig Alignment

Prior to beginning installation of the tubing/casing the alignment of the rig may require adjustment. Pulling the pipe over the hole is not good practice and leads to thread wear or damage due to excessive torque during make-up of the tubing.

3.4 Pick Up and Handling

Introduction: Many of the requirements for installing small diameter tubing (≤4½") and large diameter tubing (≥4½") are similar, however the heavier weight and torque requirements provide some differences. Following are the handling and make-up procedures for both.

3.4.1 Small Diameter (≤4½")

- Do not remove thread protectors until ready to make-up connection.
- Attach the elevators to the tubing.
- Excessive wind may require a Derrick Man for stabilization and alignment.

3.4.2 Large Diameter (≥4½")

- Do not remove thread protectors until ready to make-up connection
- Use a typical pick-up line.
- Derrick Man needed for stabilization and connection alignment.
- Derrick Man should release pick line after make-up and latch on elevators.

Caution: Do not use standard slips above 20,000 lbs.. Damage may occur. Use two sets of elevators, one to hold and one to lower.

3.5 Make-Up Procedure

3.5.1 Connection Preparation

- Clean the pin and box threads with soft bristle brush.
- Ice or other debris must be removed from the threads prior to joining.
- Inspect threads for damage or contamination.
- If solvent are used the connection must be completely dry before applying lubricant.
- Lubricate pin and box threads by applying a light even coat of STARtec lubricant using a typical dope brush. Make sure the root of thread is coated. STARtec is the only approved lubricant for use on Star 8rd products.
- Avoid contaminating coated connections or lubricant in containers with sand or debris.
- Never thin the lubricant
- Extremely cold weather will require warming of the connection and lubricant.

3.5.2 Small Diameter Connection Make-Up (≤4½")

- Gently lower pin into box until contact is felt.
- Rotate with a small strap wrench.
- Proper alignment must be maintained to prevent cross-threading or joint seizure. If seizure occurs, back it out, clean it, inspect for damaged threads.
- Re-lubricate and repeat make-up procedure.
- Abrasive powder must be applied to the strap, which will cause the strap to grip the product.
- Occasionally clean the strap with a wire brush and reapply fresh powder as needed.
- The final make-up will be made by one man (not two) with a proper sized strap wrench. To obtain optimal torque, the connection is designed for a position make-up of 3 to 4 threads typically exposed outside the female box. (Refer to Table 3.5.4a Torque Requirements)

Caution: Excessive torque can make break out of the connection difficult.

3.5.3 Large Diameter Connection Make-Up (≥5½")

- Gently lower pin into box until contact is felt.
- Rotate initially with a strap wrench.
- Derrick Man should hold the joint alignment.
- Tighten connection with tongs then latch elevators.
- Proper alignment must be maintained to prevent cross-threading or joint seizure. If seizure occurs, back it out, clean it, inspect for damaged threads.
- Re-lubricate and repeat procedure.
- After hand tight, use either a STAR metal friction wrench or a qualified power tong to complete engagement.

3.5.4 Torque Requirements

Table 3.5.4a

Thread Size in	Torque (ft / lbs)			STARtec Lubricant Jts/Gal
	OPT	MIN	MAX	
1.90	125	100	175	100
2 3/8	150	125	225	100
2 7/8	185	150	250	100
3 1/2	225	175	300	68
4	275	225	375	50
4 1/2	300	250	450	50
5 1/2	400	320	560	34
6 5/8	500	400	650	34
7	525	420	735	34
8 5/8	700	475	825	26
9 5/8	630	500	880	26

Note: Monitoring both torque and thread standoff is recommended.

3.5.5 Make-Up Precautions

- The power tongs should be equipped with accurate torque measuring equipment.
- Typical power tong back-ups can be used on the coupling or lJ box. Damage can occur if they are used on the product body.
- Never use typical pipe wrenches on STAR fiberglass tubulars.
- Slips should be cleaned frequently and slip inserts should be sharp.

3.6 Considerations For Lowering Tubing and Casing

- Lower slowly. Monitor weight indicator for evidence of bridging or other obstacles.
- Never allow string compression to exceed 75% of the tensile rating.
- Reaching total depth, stacking out or setting down temporarily is common practice, set down gently.
- Avoid abrupt stops which can result in high tensile loads.
- Stop tubing motion prior to setting slips.
- Exercise caution when lowering couplings through slips and BOP's.
- Do not exceed the internal or collapse pressure rating during cementing operation.
- Fiberglass casing is up to 50% buoyant in cement.

3.7 Considerations For Setting Tubing Tension

3.7.1 Aliphatic Amine Tubing (ONLY)

- STARWell should be used to determine recommend tension and stretch.
- Tension must be sufficient to insure that the lowest joint in the string stays in tension throughout the life of the well.
- Since weight indicators are not always accurate, use the following guide (Table 3.7.1a) for setting stretch above the neutral point (tubing hang weight) for every 100 ft. of tubing installed.

Guide for Setting Tension - in/100 ft (mm/30.48m) for Aliphatic Amine Tubing — Table 3.7.1a

API Thread Size in	Series	1½		2 3/8		2 5/8		3½		4	
Stretch in/100 ft (1) (mm/30.48m)		in	mm	in	mm	in	mm	in	mm	in	mm
Note: These guidelines can vary depending on actual well conditions, STARWell will provide more accurate setting of tension/ stretch.	1000	---	---	1	25,4	1	25,4	1	25,4	1	25,4
	1500	1	25,4	1	25,4	1	25,4	1	25,4	1	25,4
	1750	---	---	1	25,4	1	25,4	1	25,4	1	25,4
	2000	1	25,4	1	25,4	1	25,4	1	25,4	1/2	12,7
	2500	3/4	19,1	3/4	19,1	3/4	19,1	1/2	12,7	1/2	12,7
	3000	1/2	12,7	1/2	12,7	1/2	12,7	1/2	12,7	1/2	12,7
	3500	1/2	12,7	1/2	12,7	1/2	12,7	1/2	12,7	1/2	12,7
	4000	1/2	12,7	1/2	12,7	1/2	12,7	1/2	12,7	1/2	12,7

(1) Stretch pulled above neutral point.

Guide for Setting Tension - in/100 ft (mm/30.48m) for Aliphatic Amine Tubing Table 3.7.1a

API Thread Size in	Series	4½		5½		7		9⅝	
Stretch in/100 ft (1) (mm/30.48m)		in	mm	in	mm	in	mm	in	mm
Note: These guidelines can vary depending on actual well conditions, STARWell will provide more accurate setting of tension/stretch.	1000	1	25,4	---	---	---	---	---	---
	1500	1	25,4	1/2	12,7	1/2	12,7	1/2	12,7
	1750	1	25,4	---	---	---	---	---	---
	2000	1/2	12,7	1/2	12,7	1/2	12,7	1/2	12,7
	2500	1/2	12,7	---	---	---	---	---	---
	3000	1/2	12,7	---	---	---	---	---	---
	3500	1/2	12,7	---	---	---	---	---	---
	4000	1/2	12,7	---	---	---	---	---	---

(1) Stretch pulled above neutral point.

3.7.2 Anhydride & Aromatic Amine Tubing (Only)

- STARWell should be used to determine recommend tension and stretch.
- Following are two methods of calculating stretch for Anhydride and Aromatic Amine Tubing:

a. Calculating stretch for tension due to weight, applied above 0 (zero) lbs. tubing weight:

$$ST = \frac{DOP}{1{,}000} \text{ x } \frac{TT}{1{,}000} \text{ x } SF$$

Where:

ST	=	Stretch, in.
DOP	=	Total depth of packers, ft.
TT	=	String Weight plus Applied Tension, lbs.
SF	=	Stretch factor, in./lb.ft. (from Table 3.7.2a)

Example: The stretch for 5,000 feet of 2 3/8" 2000 psi with 10,000 lb. Total tensile load is:

$$ST = \frac{5{,}000\ \text{Ft.}}{1{,}000} \text{ x } \frac{10{,}000\ \text{Lbs.}}{1{,}000} \text{ x } 2.29\ \text{In./Lb.Ft.}$$

ST = 104 in. of total stretch

b. Calculating stretch due to tension applied above string weight:

$$ST = \frac{DOP}{1{,}000} \text{ x } \frac{AT}{1{,}000} \text{ x } SF$$

Where:

ST	=	Stretch, in.
DOP	=	Total depth of packer, ft.
AT	=	Applied tension, lbs.
SF	=	Stretch factor, in./lb.ft. (from Table 3.7.2a)

Example: The stretch for 6,000 feet of 2 7/8" 2500 with applied tensile of 5,000 lbs. is:

$$ST = \frac{6{,}000\ \text{Ft.}}{1{,}000} \text{ x } \frac{5{,}000\ \text{Lbs.}}{1{,}000} \text{ x } 1.64\ \text{In./Lb.Ft.}$$

ST = 44.7 In. of stretch above string weight

Table 3.7.2a

Stretch Factor (in./per 100ft) *Stretch factor based on 1,000 lb. Tensile load per 1,000 ft.*
(For Anhydride and Aromatic Amine Tubing ONLY)

Series psi	Tubing Size						
	1 1/2"	2 3/8"	2 7/8"	3 1/2"	4 1/2"	6 5/8"	9 5/8"
1000	---	3.47	2.74	1.66	1.11		
1500	5.82	3.09	2.10	1.55	0.94		
2000	4.13	2.29	1.73	1.21	0.78		N/A
2500	3.08	2.22	1.64	1.06	0.69		
3000	2.68	1.89	1.31	0.88	---		

3.8 Landing Tubing At The Well Head
Introduction - A variety of well head configurations can be used. Following is a list of typical well head configurations with precautions for make-up to fiberglass tubing.
Caution: Care should be used when connecting fiberglass threads into steel threads.

- All standard wellhead configurations are compatible with fiberglass tubing and casing.
- Check the thread compatibility prior to installation per section 3.3.7.

3.9 Hydrotesting Tubing

- Annular testing should be based on the licensing authority or end-user requirements.

3.10 Pulling Tubing

3.10.1 Release From Bottom Hole Tools Cautiously

- Relieve tension and disengage on/off tool per manufactures recommendation.
- Determine the string weight of the tubing prior to the first lift.
- A calibrated weight indicator should be used.
- Monitor weight indicator to ensure tubing is moving freely.
- Never exceed the rated tensile.

3.10.2 Stuck Bottom Hole Tools

- Never exceed tensile, compression or torque ratings when attempting to manipulate downhole tools.
- Rather than damage the tubing, it is best to shoot off tubing leaving 8'-10' above the bottom hole tools.
- Fishing of fiberglass tubing is accomplished using normal overshot or spear tools and procedures.
- Fiberglass tubing or casing can be jet or chemically cut.

3.10.3 Break Out of the Connection

- Metal friction wrenches are recommended for use on the upset near the coupling for sizes ≤4 ½".
- Sizes ≥4 ½" require the use of appropriate power tongs.
- Light tapping on the coupling utilizing a hammer and wooden block can facilitate break out.
- Place the wooden block over the engaged thread and tap with a hammer, using a consistent rhythm.
- Tapping should be done while applying constant torque.
- The application of heat to the connection may facilitate break out.

3.10.4 Disengagement of the Connection

- Exercise care to make sure all threads are disengaged prior to lifting.
- Do not continue to rotate after the last thread is disengaged.
- Lift slowly so as not to damage threads.

3.10.5 Standing Back the Tubing in the Derrick

- Replace thread protectors on tubing.
- Protect the pin end from dirt or damage.
- Set the pin end on wooden pads preferable covered with gasket rubber or some other padded material.
- Gently lower the tubing so as not to damage the male threads.
- If the tubing is left overnight and high wind potential exists it is best to tie it back securely at the board and apply a belly rope midway to the ground.
- Tubing 2 $^{7}/_{8}$" (2000#) and larger can be pulled in doubles.

Note: If the tubing is being pulled due to a pressure test failure retrieve the sample in the "as failed" condition and return to the NOV Fiber Glass System representative for analysis.

3.11 Laying Down (Storage)

- Exercise care when laying down tubing ensuring it is properly supported and resting on four equally spaced wood stripped supports.
- The threads should be cleaned using solvents, soft bristle brushes and clean rags.
- Before tubing is stored or re-used, tubing and threads should be inspected and defective joints segregated.
- All threads should be cleaned and thread protectors should be installed on the tubing.
- Store the tubing on a minimum of four wooden racks with pads equally spaced. This will keep the tubing straight, particularly if stored for a extended periods of time.

3.12 Rerunning Tubing or Casing

- Follow procedures 3.4 through 3.10
- Cleaning threads with solvents should be performed and requires absolute dryness before rerunning.
- As the threads are made-up, pulled, and re-run, the thread stand-off will begin to reduce as the threads wear.
- Inspect tubing or casing for mechanical damage.

SECTION 4

4.1 Centralizers

Fiberglass Centralizers:

- Properly size centralizers for casing O.D. and bore hole I.D..

For Steel Centralizers:

- Check fit to fiberglass body O.D. since it is larger than steel.
- Do not use retainer rings with set-screws that may damage the fiberglass casing wall.
- Do not install steel centralizers over fiberglass connections as the O.D. is larger which reduces contraction of the centralizer.

4.2 Float Equipment

- Use conventional and standard threaded equipment, check the thread compatibility. (Long Form vs. Short Form)
- Thread Lock the steel float equipment to fiberglass connections, a fiberglass male into steel female configuration is preferred.

4.3 Displacement Fluid

- Do not allow the differential collapse pressure to exceed the collapse rating of casing.

4.4 Buoyancy

- The fiberglass casing may require chaining down during cementing.
- Chains should not be in direct contact with the wall of the fiberglass casing.
- It may be necessary to fill the fiberglass casing with drilling fluids to minimize buoyancy.

4.5 Plug Pumping

- As the plug approaches the seating depth of the casing the flow rate and velocity should be reduced to prevent exceeding the maximum internal casing pressure rating upon contact with the float collar.
- A NOV Fiber Glass Systems Field Service Representative should monitor this procedure.

4.6 Drilling Out Cement

- A rock bit is recommended, not a mill.

Precautions:

- Slow down to avoid “kick out.”
- Do not exceed a sit down weight of 2,000 to 3,000 lbs.
- Do not use bit stabilizers that scratch the fiberglass casing.
- Allow cement to fully cure and reach its full compressive strength before removing suspended supports.

Recommendations:

- Use a rock bit ¼” in size under casing drift diameter.
- Use a centralizing joint, spiral drill collars, to closely fit the casing drift diameter.
- Reduce drilling rates for deviated wells.
- Do not exceed 3 to 4 degrees deviation per 100 feet.
- Before drilling out wells with deviations in excess of 6 degrees per 100 feet contact a NOV Fiber Glass Systems representative for recommendations.

Table 4.6a **Rock Bit Sizing**

Casing Size in	Anhydride / Aromatic		
	I.D. in	Drift Dia. in	Max. Bit Size in
1.90	1.50	1.41	1.16
2 3/8	1.88	1.82	1.57
	2.00	1.91	1.66
	2.16	2.10	1.85
3 1/2	2.73	2.67	2.42
	3.00	2.88	2.63
	3.19	3.13	2.88
2 7/8	2.23	2.14	1.89
	2.43	2.34	2.09
4	---	---	---
4 1/2	3.35	3.29	3.04
	3.75	3.63	3.38
	3.91	3.79	3.54
	4.00	3.94	3.69
5 1/2	4.74	4.62	4.37
6 5/8	5.50	5.38	5.13
	5.84	5.77	5.52
7	---	---	---
8 5/8	7.50	7.38	7.13
9 5/8	7.90	7.74	7.49

Table 4.6b **Rock Bit Sizing**

Casing Size in	Aliphatic		
	I.D. in	Drift Dia. in	Max. Bit Size in
1.90	1.44	1.35	1.10
2 ⅜	1.90	1.85	1.60
3 ½	2.94	2.82	2.57
2 ⅞	2.37	2.28	2.03
4	3.33	3.21	2.96
4 ½	3.85	3.73	3.48
5 ½	4.74	4.62	4.37
6 ⅝	5.50	5.38	5.13
7	5.93	5.81	5.56
8 ⅝	7.74	7.62	7.37
9 ⅝	7.74	7.58	7.33

4.7 Mixed Casing or Tubing Strings

- When steel is run below fiberglass do not exceed the tensile rating of the fiberglass product.
- The preferred crossover is a fiberglass male thread into a steel female thread.
- It is recommended that at least one male by male joint of fiberglass casing is ordered for use as a crossover at the top of the string.

4.8 Fiberglass Landing Joints

- Fiberglass Landing Joints are available
- Fiberglass Landing Joints must be sized for the well-head selected.

4.9 Drilling-Up Fiberglass Liners or Casing

- A rock bit is recommended
- Drilling rates of 3 to 5 feet per minute are recommended.
- Do not mill.

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INS 8010 August 2015