STAR™ Super-Seal Key-Lock® Installation Guide

Fiber Glass Systems | NOV

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1. Introduction

- This installation handbook is offered to assist you in the proper installation procedures of Fiber Glass Systems STAR Super-Seal Key-Lock high pressure pipe.
- If you have any questions regarding procedures in this installation handbook, please contact a Fiber Glass Systems Representative for assistance.
- 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.
- 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 correctly.
  - Understand the Field Service Policy as it relates to onsite training and/or certification.
- 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.
- 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.
- 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

• 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 SSKL 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.

1.1 Fabrication and installation assistance

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

- Type of service
- Service conditions, such as natural gas, that may require additional safety factor
- Buried or above ground installation
- Type of joint lubricant
- Type of O-ring
- Required fittings, flanges, and flange accessories
- Acquire proper tools such as pullers, straps, lubricants, and accessories
- Proper storage & handling of O-rings & Keys

1.2 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.

1.3 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, Part 4
- ASME B31.3
- Basic Fiber Glass Systems training

2. Star SSKL pipe products

NOV Fiber Glass Systems' STAR SSKL piping systems are manufactured using epoxy resin systems. All systems are heat cured for optimum chemical resistance and physical properties. The epoxy resin is hardened using one of two distinct curing agents: Anhydride or Aromatic Amine.

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 piping system.

Resin systems

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

Aromatic Amine – Ideally suited for the majority of oilfield, municipal and chemical applications that require high temperature service. Aromatic amine pipe can handle all the fluids listed above and can handle continuous service temperatures of up to 212°F (100°C).

Joining system

The STAR SSKL joint is a self-restrained joint offering a quick assembly by utilizing ductile locking keys for mechanical restraint. Joint is directly inserted with no rotation. Available with 1 or more locking keys depending on pressure requirements. Hydrostatic seal is made by means of an elastomeric O-ring.

3. Storage, handling & inspection

3.1 Storage & handling

Fiberglass reinforced pipe and fittings require special attention to storage and handling procedures. Care should be taken in transporting, unloading, handling, and storing products to prevent impact and other damage. Any person handling NOV Fiber Glass Systems pipe and fittings must be well informed about these instructions and act accordingly. Please refer to Packing & Handling Instructions (GEN1020ENG) for more detailed instructions.

Important handling requirements

- Do not drop, throw or stand on pipe or fittings
- Protect pipe and pipe ends from all types of impact and damage.
- When racking pipe and fittings, precautions must be taken to prevent pipes and fittings from sliding movement during handling and/or transport.
- When using a crane/forklift-truck, pipe lengths should be handled with a spreader bar or transportation tube.
- When lifting equipment is required, use nylon slings or chokers. Do not allow chains or cables to contact the pipe during transport or handling.
- No metal handling tools should be used in direct contact with pipe and fittings. Whenever pipe are in contact with metal, padding such as carpet or foam should be used.
- When lifted at pipe-ends, avoid touching and contamination of joining surfaces.
- Pipe and fittings should only be placed on a surface that is free from sharp objects.

When transporting pipe, spacer blocks under and between the pipe must be of sufficient width to avoid point loading, which could damage the pipe. A minimum of four blocks should be used for supporting 40-foot lengths of 14 in. and larger pipe.

For storage, a block (2 in. x 4 in. minimum) should be placed approximately every ten feet under each layer of pipe. The intent is to support the pipe and distribute the load evenly. The pipe should also be braced on the sides of the pipe rack to stabilize and prevent pipe movement. Do not place pipe on sharp edges, narrow supports, or other objects that may cause damage to the pipe. Avoid storing pipe directly on the ground. If it is unavoidable, select a flat area free of rocks and other debris that may damage the pipe.

Do not stack pipe over 8 ft high. Factory packaged pipe is shipped in easy- to-handle bundles complete with protective end caps. Leave the end caps in place until installation time to protect the pipe ends as well as to prevent dirt or other material from getting into the pipe.

Fittings are packaged in cardboard boxes and should be stored in a clean dry area. If fittings are removed from the boxes, protect male and female ends from foreign matter and exposure to direct sunlight.

If the protection on the pipe ends is damaged or removed, replace immediately with corrugated cardboard and/or heavy-duty black plastic.

The pipe can be damaged when joints or bundles of pipe are dropped during handling or shipping. Severe localized impact blows may result in damage to the fiberglass reinforced structure in the pipe wall.

Before installation, inspect the pipe's outer surface for signs of damage. If impact damage occurs, the damaged areas may be recognized by a visible star type fracture in the pipe wall. Pipe that has been severely damaged must be removed. When in doubt do not use suspect pipe unless inspected and approved by a NOV Fiber Glass Systems' representative.

3.2 Transportation

Pipe

Securely fasten pipes with ropes, bands, air bags, or side blocking to prevent damage during transport. Do not use steel cable, chains, or other hard material that will damage the pipe. Prior to loading, the floor and sides of the truck should be inspected for sharp objects. Floor and sides of the truck must be cushioned using shock-absorbing materials.

When loading pipe with a forklift, ensure forks are free of sharp objects and are protected. No other materials should be loaded on top of pipe. Nesting of pipe is only allowed when pipes are not in direct contact. Inner pipe should be wrapped with cushioning material at several places starting with pipe-ends.

The inside of the pipe must be dry and free of foreign objects that could damage the pipe. Do not drop, throw, or stand on pipe. No steel straps, chains, or other sharp materials may be used to fasten pipe. Use nylon straps for tie downs. In case of large truckloads and different diameters in same package, the smallest diameter is to be loaded first. Wooden layers are to be used to divide the total weight of materials.

SSKL pipe have machined surfaces and are protected with end caps or equivalent cushioning material. Ensure each pipe end remains free from contact with the next pipe.

Fittings

Fittings are packed in heavy-duty cartons or pallet cartons, constructed in such way that they can withstand rough handling. Cushioning materials (shredded paper, foam, etc.) must be used to prevent fittings from bouncing. When large diameter fittings are involved, it is also acceptable to pack these items by positioning and shrink-wrapping on pallets. No foreign objects are to be inserted into the fittings as this could damage the internal surface. Do not drop or throw fittings. No steel straps or other sharp materials may be used to fasten fittings.

All cartons and boxes have customer name and address, customer order number and NOV Fiber Glass Systems order number and content listed on the outside. Boxes containing adhesives (that may have special shipping requirements) must be clearly identified using appropriate hazardous labels.

Domestic 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.
- 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.

3.3 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 end protectors and damage. Replace end protectors as soon as possible.
- 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.

4. Installation tools & equipment

Check the presence and quality of joint materials (keys and O-ring) material and equipment (Photo 1). The tools and joint material listed below are, as a minimum, required to make a Key-Lock joint. All items are available from NOV Fiber Glass Systems except for items 6, 7 and 8.

1. Ratchet Pullers (Power-puller or Come-Along) (2x)
2. FGS Approved Joint Lubricant
3. Band Clamps (2x)
4. Pulling Rings (4x)
5. O-ring
6. Bucket with Water
7. Screwdriver
8. Mallet
9. Locking Key(s)

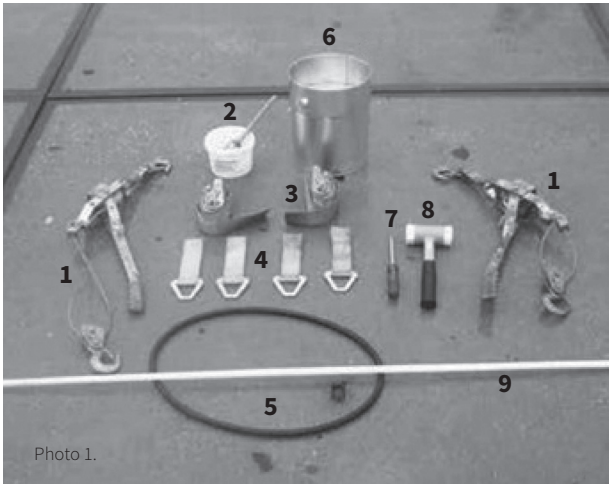

Photo 1.

5. SSKL pipe installation

5.1 General installation considerations

- SSKL pipe joints should be assembled using the standard recommended installation equipment and procedures. This equipment provides a fast assembly technique while giving the installers a sense of any increased resistance due to bound up pipe or pinched O-ring. Power installation equipment may have comparable installation rates but lacks the feedback mechanism to discern potential issues.
- Whenever possible, it is preferred to install the male end into the female end. This male end will then be lifted into the air, allowing for easy inspection, cleaning, lubrication, and installation of the O-ring. Potential contamination of the male end from any kicked-up soil will be minimized. Refer to Section 6 for proper joint cleaning and preparation.
- O-ring should only be placed on the joint just prior to joint assembly. If joint is disassembled for any reason, O-ring must be cut and discarded.
- Female ends should be raised above the trench surface by 10 inches (25 mm) or greater using blocks or sandbags. This will also ease the effort to align the pipe during insertion.
- The female end of the pipe should remain covered as long as possible to prevent sand contamination.
- It is very important that the joints be aligned properly. The alignment of the joint should be checked prior to pulling it together.
- Initial tension on each ratcheting puller should be equal prior to pulling together the joint.

- Installers should pull each ratcheting puller at the same rate. If one side is pulled faster than the other, a potential to misalign and pinch the O-ring may occur.

  Whenever possible, it is preferred that a single person operate the two ratcheting pullers to maintain even tension and alignment.

- Having an installer slightly wiggle the free end of the pipe during the pulling process can aid in the speed of assembly. This is principally needed 24 in. and above.
- When pulling the joints together, an installer should have one of the locking keys ready to be pressed into one of the insertion holes. Once the joint comes into alignment, the key will slip into the hole. All forward movement should be stopped at this point. The installed keys will be biased toward the engaged position. This is done to minimize the amount of potential movement of the joint during hydro-testing.
- There is no requirement on order of key insertion or the number of keys to be installed at the same time.

5.1.1 Installation of elbows & tee's

- It is recommended to have two standard pipe lengths on each side of the fitting for all direction changes. This allows for flexibility in the pipeline due to expansion of the line. Gender changes to maintain pipe-lay orientation should be done outside of these two standard pipe lengths.
- It is preferred to make field adjustments with bond-on adapters whenever possible. If factory nipples are used, it is important to note that these nipples are heavy walled pipe sections and should be considered rigid. Length adjustments with heavy walled nipples should be made two or more pipe lengths away from any direction change.

- Never make alignment changes using multiple nipple sections near direction changes. The SSKL joints will square-up under thrust forces. Doing so may result in elevated bending stresses in the nipple joints.
- All line adjustments made using the bending radius of the pipeline should be made 2 or more pipe sections away from the fitting. Line runs into and out of direction changes should be at the native angle of the fitting.
- Extreme care should be taken if thrust blocking is used on fiberglass pipelines. This is generally not done primarily due to differential settlement of the thrust block over time. This can lead to shear and bending stresses in the pipeline near the thrust block.
- Some installations make thrust blocking unavoidable. Poor soils, large temperature swings, risers out of the ground and sharp turns into tight casings will often require some form of blocking. In these situations, care must be taken to minimize any relative movement of the thrust block to the adjacent pipe. In all cases where a thrust block is used, the adjacent pipe section should be backfilled prior to any hydrotesting. This will prevent potential column buckling of the line during the hydro-test.
- If thrust blocking is required, please contact FGS engineering for recommended practices.
- Trenches at direction changes must be prepared to fit available fitting angles. Do not flex the line near a direction change to fit the trench. Direction change should be in the middle of trench entering and exiting for at least 2 pipe lengths. This is to ensure there is sufficient clearance for lateral movement of the line during hydro-test.
- Bond-on adapters can be used when making field adjustments. These will allow for standard wall pipe to be made into as-desired nipple & pup joint lengths.

In addition, they will retain all the flexibility of a standard pipe wall that is not available with heavy walled nipples. If nipple or pup-joint is less than 5 ft in length, it is preferred that these field adjustments be installed 2 or more pipe lengths away from any direction changes.

5.2 Installation of underground pipelines

SSKL pipes may be installed in various soils conditions. Underground pipeline systems require proper trench structuring, product assembly and installation. AWWA M45 is a good resource to reference when working with buried fiberglass pipelines.

5.2.1 Burial depth

- Minimum burial depth of 3 ft (0.9 m) of stable cover is recommended.
- Maximum burial depth is based on site-specific, bedding, backfill and native-soil conditions. Please refer to AWWA M45 for recommendations on burial depths.
- Burial depth should always be below the frost line.

5.2.2 Line adjustments

The SSKL pipe may be flexed to accommodate line lay adjustments. At no time should the pipe be flexed to a radius smaller than the minimum allowable bend radius. Refer Figure 1 for graphical representation of pipe flexure.

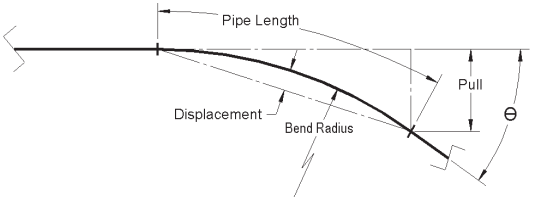

Figure 1. Bend Radius of Pipe

Table 1. Maximum allowable pull, displacement and angle for pipe

Nominal diameter		40 ft. Nominal length[1]					50 ft. Nominal length[1]				
		Pull		Displacement		θ	Pull		Displacement		θ
in	mm	in	mm	in	mm	degrees	in	mm	in	mm	degrees
8	200	14.1	359	3.5	90	3.8	23.1	586	5.8	147	4.8
10	250	11.3	286	2.8	72	3.0	18.4	467	4.6	117	3.8
12	300	9.4	239	2.4	60	2.5	15.4	391	3.8	98	3.2
14	350	8.8	224	2.2	56	2.3	14.4	366	3.6	92	3.0
16	400	7.9	200	2.0	50	2.1	12.9	327	3.2	82	2.7
18	450	7.3	186	1.8	47	1.9	12.0	304	3.0	76	2.5
20	500	6.8	172	1.7	43	1.8	11.0	280	2.8	70	2.3
24	600	5.9	150	1.5	38	1.6	9.7	245	2.4	61	2.0
30	750	4.7	119	1.2	30	1.2	7.6	194	1.9	49	1.6
36	900	4.0	102	1.0	25	1.1	6.5	166	1.6	41	1.4
40	1000	3.7	93	0.9	23	1.0	6.0	152	1.5	38	1.2

[1] Values are based on highest pressure class product using actual lengths in lieu of 40 ft. and 50 ft. nominal lengths, respectively.

5.2.3 Trench preparation

Final bedding of the trench must be as uniform and continuous as possible (Figure 2). Before backfilling, fill all gaps under the pipe with proper bedding material. Avoid sharp bends and sudden changes in slope. It is important to remove all sharp rocks, cribbage, or other foreign objects that could contact the piping. The trench shape is determined by the classification of the soil, which can be unstable or stable.

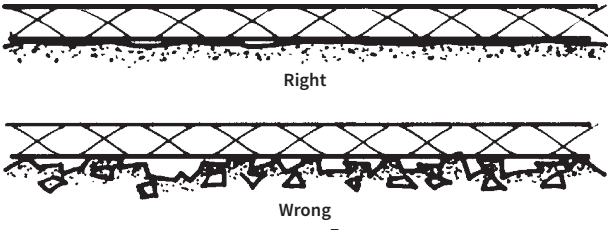

Figure 2. Proper trench bottom preparation

5.2.4 Bedding requirements

Use recommended bedding material a minimum of 6 inches thick at the bottom, sides, and top of the piping (Figure 3).

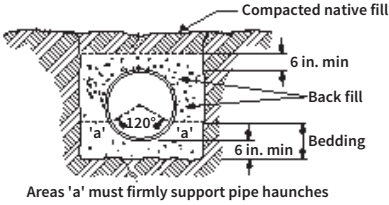

Figure 3. Proper bedding & backfilling

Adjacent pipes should be spaced the greater of 6 inches or one pipe diameter. The piping can be laid directly on the trench bottom if the native soil meets the requirements of a recommended bedding material (Table 2). In some situations, the trench bottom can be "scratched" such that a natural cradle of dirt is formed. Never lay fiberglass piping directly against native rock or shale. Always use dry, unfrozen bedding materials that do not contain foreign objects or debris. 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.

Table 2. Recommended bedding materials

Bedding material	Compaction proctor density
Crushed rock or pea gravel ¾ in. 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%

5.2.5 Backfill guidelines

- Loose backfill free of large rocks or debris must be used in the pipe zone (6 in. (150 mm) around the pipe).
- Reference Table 2 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.
- Dumping large quantities of backfill material at one spot on top of the pipe may cause damage.

- Backfill material should be compacted in layers of 6 inches (150 mm). The pipe should not be displaced due to backfilling.
- When reaching a compaction height of 0.3 * ID below the crown of the pipe, compaction may be continued in layers of 12 inches (300 mm).
- If possible, backfill leaving 2 ft. (600 mm) on each side of connections exposed for inspection during hydro test.
- Do not backfill over connections until hydro-testing is complete.
- Cold weather backfilling with frozen material in the pipe zone must be avoided as 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.

5.2.6 Pipe support

Fiberglass pipe is flexible and requires the support of the bedding material to keep the pipe round in burial applications. It is very important that a recommended bedding material is properly compacted around the entire circumference of the pipe (Figure 4). Tamp the bedding material under the bottom half of the piping to prevent voids or areas of low compaction. Vibratory or similar tamping equipment can drive small stones or debris into the pipe wall if they are present in the bedding material. Avoid striking the pipe with tamping equipment as the pipe may be fractured.

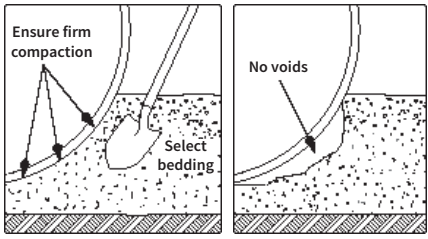

Figure 4. Proper Haunch Filling

5.2.7 High water tables or vacuum

Consult factory for recommendations.

5.2.8 Road crossings

When laying fiberglass pipe under road crossings, it may be necessary to pass the pipe through conduit to protect the pipe. Use centralizers to prevent rubbing or point loading of the pipe and joint against the conduit. Centralizers should be spaced evenly and not exceed 10 ft (3 m) between support points.

Whenever possible, pipe sections in conduits should be pulled into place. If push installation of pipe sections is unavoidable, never exceed ½ of the short-term tensile rating of the pipe. If push sections exceed 8 pipe sections, contact an FGS Field Service Technician.

It is important to note that pipe sections pushed into place will concentrate slack in each joint. This may result in additional movement (above and beyond elastic expansion) at directions changes installed near the conduit during hydro-test. Precautions to address this movement should be taken.

5.2.9 Wall penetrations

Where the pipe goes through or passes under a concrete structure, precautions must be taken to prevent bending or point loading of the pipe due to settling. A minimum 2 in. thick pad of resilient material should be wrapped around the pipe

to provide flexibility and prevent contact with the concrete. If bolts are used in the resilient material, care should be taken that the bolts, nuts, or washers cannot come into contact with the pipe. Bedding depth under the pipe should be increased to a minimum of 12 in. or one pipe diameter, whichever is greater, for one pipe joint length away from the concrete (This is done to prevent differential settlement of the pipe and subsequent bending at the penetration).

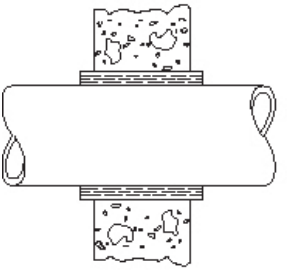

Figure 5. Wall penetration

5.3 Anchors, guides and supports

Pipe Hangers

Pipe hangers such as those shown in Figure 6. are often used to support pipe in buildings and pipe racks. However, the use of too many hangers in succession can result in an unstable line when control valves operate, and during pump start-up and shutdown. To avoid this condition, the designer should incorporate auxiliary guides periodically in the line to add lateral and axial stability.

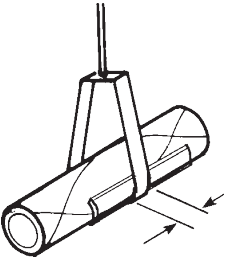

Figure 6. Pipe hanger

Pipe guides

Pipe guides are rigidly fixed to the supporting structure and allow the pipe to move in the axial direction only (Figure 7). Proper guide placement and spacing are important to ensure proper movement of expansion joints or loops and to prevent buckling of the line.

The guiding mechanism should be loose so it will allow free axial movement of the pipe. Brackets are double-nutted so they cannot be pulled down tight.

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

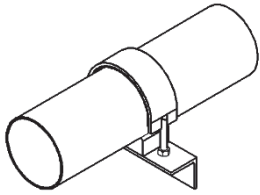

Figure 7. Pipe guide

Pipe supports

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

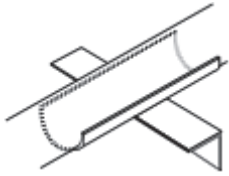

Figure 8. Sleeve

NOTE: Properly spaced supports do not alleviate the need for guides as recommended in the preceding section. Supports that make only point contact or that provide narrow supporting areas should be avoided. Some means of increasing the supporting area should be used; support saddles as shown in Figure 8 are acceptable. Contact FGS for saddle availability. Support pumps, valves, and other heavy equipment independent of the pipe.

Pipe anchors

Pipe anchors divide a pipeline into individual expanding sections as shown in Figure 9. In most applications, major pieces of connected equipment, such as pumps and tanks, function as anchors. Additional anchors are usually located at valves, near changes in direction of the piping, at blind ends of pipe, and at major branch connections. Provisions for expansion should be designed into each of the individual pipe sections. Refer to Engineering & Piping Design Guide, for a thorough discussion on supports, anchors and guides.

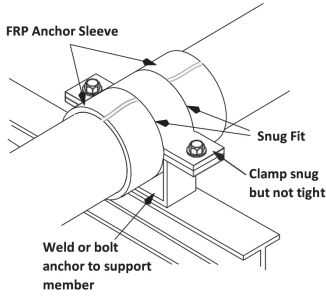

Figure 9. Pipe Anchor

6. SSKL joint assembly

When ready to join the pipes, remove the end protection from both the male pipe end and female pipe end (Photo 2). End protection, supplied by NOV Fiber Glass Systems, should be removed just prior to assembly to keep joining surfaces and grooves clean.

Clean the grooves and sealing surface of the female pipe end or fitting, using a clean dry rag or a clean paintbrush (Photo 3). Clean the grooves (both key and O-ring) of the male pipe end.

Photo 2.

Photo 3.

Brush, or rub a layer of joint lubricant into the O-ring and key grooves of the male pipe end (Photo 4).

Lubricate the inside of female pipe end and locking key groove with ample amounts of lubricant (available on order NOV Fiber Glass Systems - Photo 5).

Photo 4.

Photo 5.

Note that the pipe is already in place and has been properly rotated so the keyhole of the joint is conveniently positioned.

Apply lubricant only when you are ready to complete the joint.

Keep lubricated surfaces clean and free of sand and dirt as contamination is likely to interfere with joining and sealing. Proper lubrication of the O-ring and joint surfaces is important to avoid cutting the O-ring or rolling it out of place during assembly.

6.1 O-ring placement

Clean the O-ring with water or a clean rag (Photo 6). Check O-ring for damages and correct size.

Lubricate entire surface of the O-ring and slip it into the first endmost groove (O-ring groove) on the male end.

Distribute the O-ring evenly in the groove by slipping a screwdriver under it and sliding the screwdriver around the joint (Photo 7).

Be careful not to damage the O-ring. A sound O-ring is the key to a leak-tight joint.

Photo 6.

Photo 7.

6.2 Pipe insertion

Rotate the pipe so that the key holes in the female pipe end are in the proper position for easy access (usually pointing "up"). Align the male pipe end against the female pipe end already in place for a straight concentric entry. Proper alignment is essential for joining (Photo 8).

Deflect the joint to conform to the actual horizontal and vertical alignment of the trench only after the joint is fully assembled in the straight position.

Place the band clamps (available from NOV Fiber Glass Systems) on each side of the joint. It is often convenient to place one band clamp just behind the female end or coupling and the other about 1.5 meter (4.5 ft) from the male end. Make sure the pulling rings are positioned at 3 o'clock and 9 o'clock (Photo 9).

Photo 8.

Photo 9.

Ratchet pullers (available from NOV Fiber Glass Systems) are recommended for joint assembly. Connect the ratchet pullers to pulling rings attached to the band clamps on either side of the pipe and pull the pipes together (Photo 10).

Tighten the ratchet pullers evenly on both sides so the O-ring enters smoothly and without being pushed or rolled out of its groove.

Insert the male pipe end until the scribe mark aligns with the leading edge of the female pipe end (Figure 10). To prevent slipping of the band-clamps, one may choose to use rubber pads under the band clamps. Do not overtighten the band clamps as this may crush the pipe wall. Rubber pads or saddles may be placed underneath the band clamp to prevent pipe damage. Saddles can be made from left over pipe pieces (cut in 90° pieces).

Straightness of entry adds significantly to the ease of assembly.

Look along the pipes and carefully observe concentricity and uniformity of entry.

Keep keys ready for insertion when the scribe mark is about 6 mm (0.25 in) away from the leading edge of the female pipe end.

Photo 10.

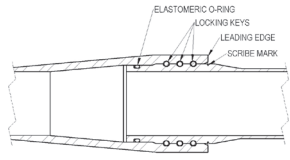

Figure 10.

6.3 Driving the keys

Check key(s) for damage and correct sizes.

Lubricate the locking key(s) (supplied by NOV Fiber Glass Systems) at leading end before insertion (Photo 11).

Place lubricated locking key(s) into the insertion keyhole(s) and slowly pull the pipes together until the key(s) slip(s) into the keyway(s).

Check the pipe alignment again by looking along the pipe and by aligning the scribe mark on the male pipe end with the edge of the female pipe end.

Use a hammer or mallet (wooden hammer) to drive the locking keys through the insertion holes and into the keyways (Photo 12) until the leading end can be seen in the insertion hole.

Approx. 75 to 100 mm (3 to 4 inch) of the key(s) will stick out of the key hole. Caution: Drive the key only until you can see its leading end through the insertion hole. Alternatively, predetermine the exposed length of key for a completed joint and use this as a guide for determining full key insertion.

Photo 11.

Photo 12.

After driving the key(s), remove ratchet pullers and band clamps (Photo 13).

Photo 13.

For above ground joints that may be disassembled in the future for maintenance or other reason, the following is recommended:

1. Protect the projecting key(s) of piping exposed to sunlight or other ultraviolet radiation from embrittlement.
2. Spray all exposed key surfaces with a black acrylic coating or wrap them with duct tape within several days after installation.

6.4 Positioning and aligning the joined pipe

After driving the key(s) and removing the ratchet pullers and band clamps, deflect the pipe to fit the supports or trench bottom. With the pipe fully supported in its final position, release the lifting straps.

Note: When installing buried pipe in sag vertical curves, it may be necessary to leave the lead lifting strap in position to align the next joint during assembly.

To avoid excessive movement and bending at turns and branches during the hydrostatic test, pull straight sections of joined pipe forward as assembly progresses, using ratchet pullers or other means to remove play in the joints.

6.5 Cutting pipe to length

Special pipe lengths are frequently required for fit up. When pipe is shortened by cutting-off factory prepared ends, new male ends must be furnished by bonding on end adapters. Cutting and bonding often can be avoided by using factory made short lengths (pups) with male ends. Special tools, equipment and assembly instructions are available from your NOV Fiber Glass Systems representative.

6.6 Connections to other piping and/or equipment

Bondstrand GRE pipe may be connected to either metallic, or thermoplastic piping using flanges drilled to ANSI Standard B16.5 or B16.47. Other flange drillings are available on special order. Consult NOV Fiber Glass Systems literature for complete flange assembly instructions.

In special situations where flange connections are not possible, special metallic adapters may be fabricated. These typically are SSKL-Male by weld neck adapters. The adapter may then be welded to the metallic piping and used to directly connect to the SSKL Fiberglass pipe.

Important: Where STAR SSKL piping is connected to metallic pipe, anchor the metallic pipe securely at the point of connection so expansion and contraction of the metal line is not transferred to the STAR SSKL line.

7. Field hydrostatic testing

7.1 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 SSKL pipe – first 5,000 ft maximum (1,500 m).
  - Fitting intensive piping projects – first 50 joints maximum.

7.2 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. Soft pigs are used to prevent scraping and scaring of inside surface of the pipe.
- 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.

7.3 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 even increments at a rate no faster than 20% of the pressure rating per minute or 200-psi per minute, whichever is less.
- Stop and hold the pressure at each increment for 5 to 15 minutes.
- **Maximum test pressure should not exceed 1.25 times label rating of the pipe.**
- Pressure should be measured at the lowest elevation point of the pipe segment undergoing hydrotest.
- **Caution:** Do not exceed the maximum allowed hydrotest pressure of the lowest rated component of the system.
- Typical test durations of 2 to 24 hours are typical, depending on the diameter and length of line tested. Contact Fiber Glass Systems for a recommended hydro-test procedure if needed. Typical procedure will include:

- A short-term system integrity at the maximum hydrotest pressure. This portion of the test is typically 1 hour long and will verify the structural integrity of the installed pipe system.
- An O-ring leak test at rated pressure or less. This portion of the test will verify that no leaking O-rings are present.

- Inspect the line at a low (safe) pressure by walking the line and visually inspecting for leakage, over bending, or evidence of damage. Cut and damaged O-ring will generally have leakage at low pressures.
- 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.

7.4 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.

8. Field fabrication

Special length nipples are often required to locate a fitting or flange in a certain location or to make a repair. There are two methods for fabricating a nipple or spacing out of a fitting for SSKL Products.

8.1 Field bonded nipples

Field bonded nipples allow for fine adjustments of installed pipelines. Field nipples and shorts may be fabricated using a bond-on male adapter. Key-Lock Male (KLM) x Taper-Female (TF) adapters are available for all sizes, but limited pressure ranges. Standard pipe sections can be cut to length and either Male x Male or Male x Female Key-Lock pipe sections can be made. Field tapering tools, adhesive kits and procedures are all available from Fiber Glass Systems. Personnel conducting any field bonding should be trained and certified by Fiber Glass Systems. Table 3 below provides the availability of bond-on male adapters.

Table 3. Availability of bond-on male adapters

Nominal diameter		Pressure rating			
in	mm	300 psi (20 bar)	500 psi (35 bar)	750 psi (50 bar)	1000 psi (70 bar)
8	200	✓	✓	✓	✓
10	250	✓	✓	✓	✓
12	300	✓	✓	✓	✓
14	350	✓	✓	✓	✓
16	400	✓	✓	✓	
18	450	✓	✓	✓	
20	500	✓	✓	✓	
24	600	✓	✓		
30	750	✓	✓		
36	900	✓			
40	1000	✓			

8.2 Prefabricated factory nipples

Factory manufactured Male x Male nipples are available in various sizes. Table 4 provides the standard-length options. Length are listed at lay-length adjustments. Nipple overall-lengths will be lay-length plus 2X joint insertion length.

Table 4. Factory made nipple lay-lengths

Diameter range	Pressure rating	Lay length adjustment	
8 inch (200 mm) ↓ 40 inch (1000 mm)	Full pressure range	1.0 ft	0.30 m
		2.0 ft	0.61 m
		4.0 ft	1.22 m
		6.0 ft	1.83 m
		8.0 ft	2.44 m
		10.0 ft	3.05 m
		15.0 ft	4.72 m

8.3 Repair methods

Multiple methods exist for the repair of Super Seal Key-Lock pipe depending on the installation conditions. The following are a summary of the repair methods and the limitations of each. Please contact FGS Field Service for any repairs.

8.3.1 Prefabricated repair joint

Purchase a prefabricated repair joint designed to replace a standard joint of pipe. This method provides a means to replace a pipe section with minimal excavation of the adjacent pipe sections.

- Confirm the exact length of pipe section to be replaced falls within the tolerance of the repair joint. Greater than 95% of all SSKL pipe shipped are within this tolerance.
- Excavate damaged pipe and adjacent pipe sections, exposing enough pipe to laterally offset the pipe one full diameter.

- Cut and remove center section of the damaged pipe.
- Remove the remaining ends of the damaged pipe.
- Install the repair-joint pipe sections.
- Align the ends and close the joint. Closure may consist of slip coupling or flange set depending on size and pressure class.

8.3.2 Replace with standard pipe

This method is available when a long straight run of pipe is adjacent to the damaged pipe. This technique provides a means to replace a damaged pipe section with an exact replacement. Consult with FGS field service for proper procedure.

- Confirm the exact length of pipe section to be replaced and confirm a replacement is available.
- A sufficient section of the long run of pipe must be fully excavated.
- Cut and remove center section of the damaged pipe.
- Remove the remaining ends of the damaged pipe.
- Use a team of excavators or side-boom cranes to lift a catenary in the pipeline away from the removed damaged joint. It is critical that this is done in a way not to exceed the minimum bending radius of the pipe. This will draw the free end of the line away, making room for the new pipe section.
- Insert new pipe section and make the joint one side.
- Gently have the lifting team lower the pipeline and make the final closure.

8.3.3 Butt & wrap procedure

This method may be used on standard pipe sections where access to 360° of the damaged pipe is available. This method may be used to reinforced damaged pipe sections or replace sections of pipe without disturbing the adjacent joints. Consult FGS personnel for proper procedure and training. Butt & Wrap kits are available from FGS.

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