PLIDCO® SPLIT+SLEEVE

Permanently repairs a variety of pipelines

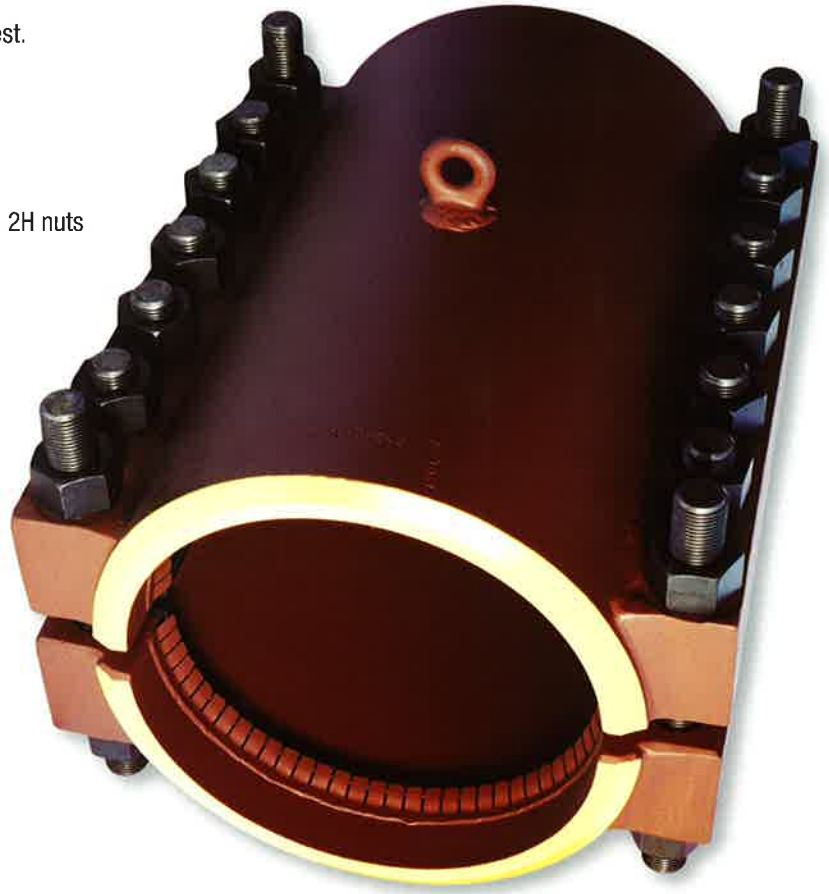
Standard working pressure is 1000 psig. Fittings are available in longer lengths such as 18", 24" and longer as well as higher working pressures such as 1500 psig or 2000 psig. If higher working pressures or longer length is needed, it can be designed and built to meet your requirements. Fittings are tested to 1.5 times the design pressure.

Buna-N packing is standard.
Viton, Silicone and other materials are available upon request.

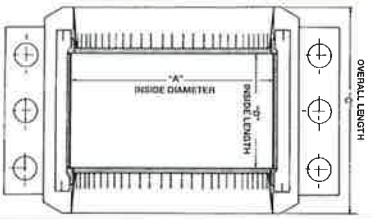
Standard body materials:
- ASTM A106 Gr. C
- ASTM A216 Gr. WCC
- ASTM A516 Gr. 70
- Standard bolting is ASTM A193 Gr. B7 with ASTM A194 Gr. 2H nuts

Options:
- Marine epoxy paint for corrosion protection
- Hinges to ease with installation and handling
- Vents available per customer specifications
- Anodes for cathodic protection
- NACE MR0175/ISO 15156 compliant materials

Patented steel GirderRings prevent displacement & damage of seals during installation.



DIMENSIONS STANDARD PLIDCO® SPLIT+SLEEVES

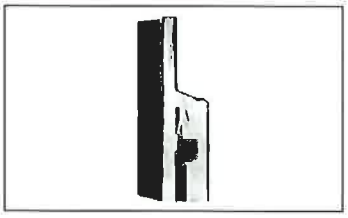


STANDARD LENGTH
PLIDCO® SPLIT+SLEEVE SPECIFICATIONS
1000 PSIG MAX. WORKING PRESSURE

API Pipe Size	Inside Diameter "A"	Inside Length "D"	Overall Length "C"	Approx. Weight Pounds
1-1/2	2-7/8	5-1/2	9	26
2	3-1/8	5-3/4	9	23
2-1/2	3-3/8	5-1/4	8-1/2	70
3	4	5-1/4	8-1/2	34
4	5	5-1/4	8-1/2	42
6	7-1/8	5-1/4	9	62
8	9-1/8	5-1/4	10	125
10	11-1/4	5-1/2	10-1/2	147
12	13-1/4	5-1/2	10-1/2	230
14	14-1/2	8	14	385
16	16-1/2	8	14	420
18	18-1/2	8	14	555
20	20-1/2	8	14	580
22	22-1/2	8	14	635
24	24-1/2	8	14	680
26	26-1/2	8	14	865
28	28-1/2	8	14	930
30	30-1/2	8	14	990
32	32-1/2	8	14	1025
34	34-1/2	8	14	1200
36	36-1/2	8	14-1/8	1330
38	38-1/2	8	14-1/4	1405
40	40-1/2	8	14-1/4	1445
42	42-1/2	8	15-7/8	1805
48	48-1/2	8	16	2220

Dimensions in inches.

CONSTRUCTION FEATURES



Sectional view of circumferential GirderRings show how they make displacement of packing impossible by securely supporting and holding it in place.

Cross-section of Plidco® Split+Sleeve shows location of longitudinal packing and patented steel GirderRings which hold packing securely in place to prevent its displacement during installation.

If installation is to be welded, simply fillet-weld ends, seal-weld sides, and seal-weld nuts and studs.

PIP046

ISO 9001:2008 REGISTERED FIRM
ISO 14001:2004 REGISTERED FIRM

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"Working together to make hazardous piping safer"

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PLIDCO® SPLIT+SLEEVE INSTALLATION INSTRUCTIONS

!! WARNING!!

IMPROPER SELECTION OR USE OF THIS PRODUCT CAN RESULT IN EXPLOSION, FIRE, DEATH, PERSONAL INJURY, PROPERTY DAMAGE AND/OR HARM TO THE ENVIRONMENT.

Do not use or select a Plidco Split+Sleeve until all aspects of the application are thoroughly analyzed. Do not use the Plidco Split+Sleeve until you read and understand these installation instructions. If you have any questions, or encounter any difficulties using this product, please contact:

PLIDCO "DEPARTMENT 100" at 440-871-5700
toll free U.S. & Canada at 800-848-3333

READ CAREFULLY

The person in charge of the repair must be familiar with these instructions and communicate them to all personnel involved in the repair crew.

Safety Check List

Pipeline repairs can be made with the pipeline in operation or shutdown.

- ❑ 1. Read and follow these instructions carefully. Follow your company's safety policy and applicable codes and standards. If the Plidco Split+Sleeve is to be installed underwater, be sure to read the *Underwater Installation* section.
- ❑ 2. The Plidco Split+Sleeve should never be used to couple pipe unless sufficient end restraint is provided such as with a Plidco Clamp+Ring. The Plidco Split+Sleeve has no end restraint rating in its unwelded condition, and if so utilized could result in EXPLOSION, FIRE, DEATH, PERSONAL INJURY, PROPERTY DAMAGE, AND/OR HARM TO THE ENVIRONMENT.
- ❑ 3. Observe the working pressure and temperature on the label of the Plidco Split+Sleeve. Do not exceed the maximum working pressure or temperature as indicated on the unit.
- ❑ 4. When repairing an active leak, extreme care must be taken to guard personnel. Severe injury or death could result.
- ❑ 5. If the pipeline has been shut down, repressuring should be done with extreme caution. Repressuring should be accomplished slowly and steadily without surges that could vibrate the pipeline and fitting. Industry codes and standards are a good source of information on this subject. Except for testing purposes, do not exceed the design pressure of the Plidco Split+Sleeve. Personnel should not be allowed near the repair until the seal has been proven.

Pipe Preparation

1. Remove all coatings, rust and scale from the pipe surface where the circumferential seals of the Plidco Split+Sleeve will contact the pipe.
2. The seal can tolerate minor surface irregularities up to ± 1/32 inch (0.8 mm).
3. Ensure the pipe is round where the circumferential seals will contact the pipe. Repositioning the Plidco Split+Sleeve or the use of a different length Plidco Split+Sleeve may be required.

Installation

Careless handling can damage the seals and GirderRings. Lifting devices such as chains, cables or lift truck forks should not be allowed to contact the seals or GirderRings. Contact can result in the seals being pulled from their grooves. (See Figure 1)

1. Coat all exposed surfaces of the seals with a lubricant. The chart below lists the lubricants that are recommended for the various seals. The customer must determine if the lubricant is compatible with the product in the pipeline.

Petroleum based lubricants	= A
Silicone based lubricants	= B
Glycerin based lubricants	= C
Super Lube® Grease (1)	= D

		Temperature (2)
Buna-N	A, B, C, D	225°F (107°C)
Viton	A, B, C, D	250°F (121°C)
Silicone	C, D	300°F (149°C)
Neoprene	B, C, D	250°F (121°C)
Aflas	A, B, C, D	225°F (107°C)
Hycar	A, B, C, D	180°F (82°C)
Teflon	A, B, C, D	500°F (260°C)
Kevlar	A, B, C, D	750°F (399°C)

(1) Super Lube® Grease is a product of Synco Chemical Corporation. (www.super-lube.com)
(2) Temperature limit is for the seal material only and does not imply the pressure rating is necessarily applicable at this limit.

2. Clean and lubricate all studbolts and nuts, and prove free and easy nut running prior to the installation.
3. Assemble the Plidco Split+Sleeve around the pipe making sure the yellow painted ends are matched and that the fitting is centered over the leak and/or damaged area as much as possible. Sometimes it is helpful to loosely assemble the Plidco Split+Sleeve to one side of the leak, than reposition it centered over the leak.
4. All studbolts and nuts should be uniformly torqued as indicated by the *Plidco Torque Chart* located on the back cover. The best results are obtained by maintaining an equal gap all around, between side bars, while tightening the studbolts. Ensure a minimum of 1/4 inch (6.4 mm) of studbolt extends beyond the nut.
5. To complete assembly, ALL studbolts should be rechecked at the recommended torque. Keep in mind; an increase in torque on one studbolt can cause a decrease in torque on neighboring studbolts.

6. The side bars are gapped approximately 1/8 inch (3.2 mm) when the Plidco Split+Sleeve is fully tighten.

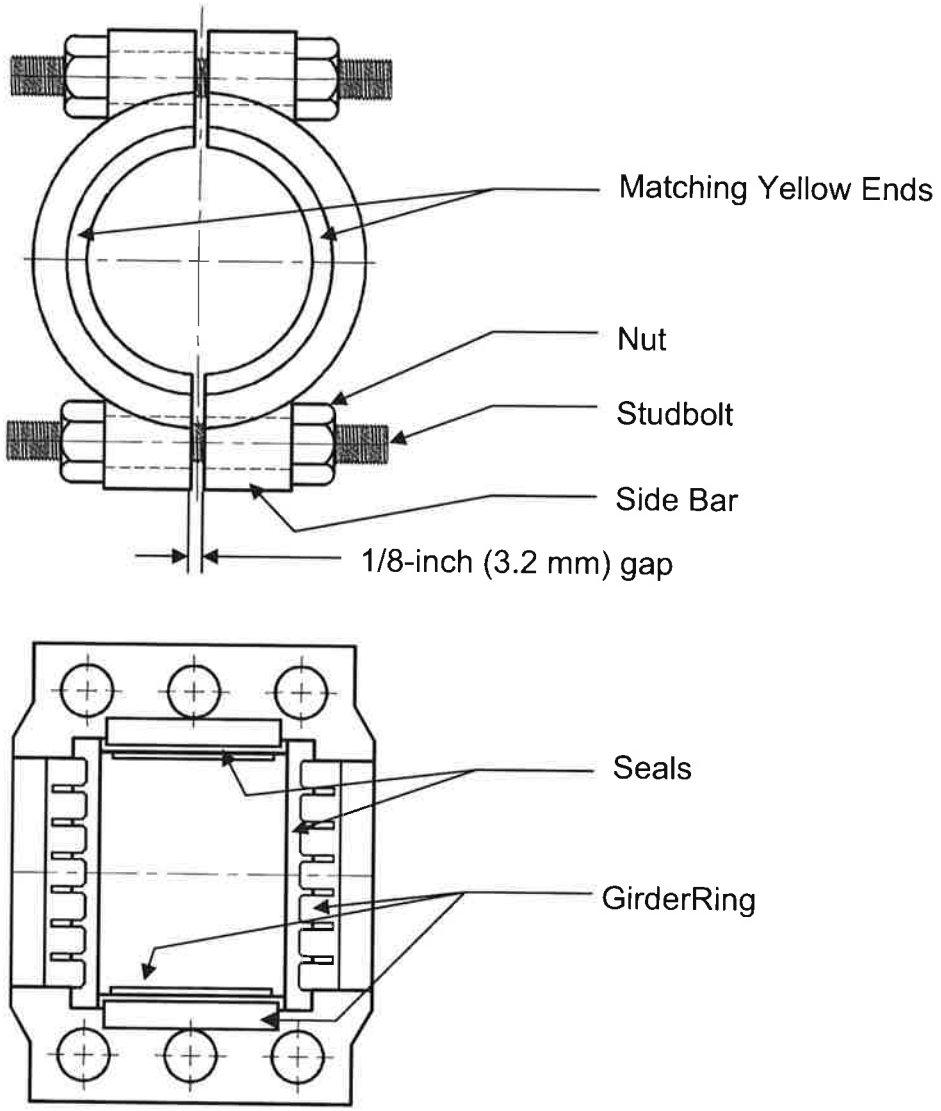


Figure 1

Repressuring and Field Testing

If the pipeline has been shut down, repressuring should be done with extreme caution. Repressuring should be accomplished slowly and steadily without surges that could vibrate the pipeline and fitting. Industry codes and standards are a good source of information on this subject. Except for testing purposes, do not exceed the design pressure of the Plidco Split+Sleeve. The Plidco Split+Sleeve can be field tested up to 1½ times its design pressure. Personnel should not be allowed near the repair until the seal has been proven.

Field Welding Instructions

Failure to follow field welding instructions could result in explosion, fire, death, personal injury, property damage and/or harm to the environment.

PIPELINE SHOULD BE FULL AND UNDER FLOW

Use weld material with equal or greater tensile strength than the pipe. Carefully control the size and shape of the circumferential fillet welds. The size of the fillet weld should be at least 1.4 times the wall thickness of the pipe. This assumes a 1.0 joint efficiency. You may need to select a different joint efficiency based on your level of inspection. Strive for a concave faced fillet weld, with streamlined blending into both members; avoid notches and undercuts. The smoother and more streamlined the weld, the greater the resistance to fatigue failure. The worst possible shape would be a heavy reinforced convex weld with an undercut. Improper weld shape can lead to rapid fatigue failure, which can cause leakage, rupture or an explosion with attendant serious consequences.

Welders and weld procedures should be qualified in accordance with API Standard 1104, *Welding of Pipelines and Related Facilities*, Appendix B, *In-Service Welding*. We strongly recommend the use of a low hydrogen welding process such as GMAW or SMAW using low hydrogen electrodes (E-XX18) because of their high resistance to moisture pick-up and hydrogen cracking. These are also the preferred welding process for seal welding the studbolts and nuts. SMAW electrodes must be absolutely dry.

It is very important that the field welding procedure closely follow the essential variables of the qualified procedure so that the quality of the field weld is represented by the mechanical tests performed for the procedure qualification.

We do not recommend the use of thermal blankets for pre-heating. Thermal blankets can generate hot spots and reduce the ability of the Plidco Split+Sleeve to dissipate welding heat in the vicinity of the seals. We recommend a small torch, such as a cutting torch, being careful not to aim the flame directly into the gap between the Plidco Split+Sleeve and the pipe towards the seals. The flame from a preheat torch is helpful in burning off oils and other contaminates. Do not use a large torch, commonly called a rosebud, because of the difficulty controlling the size of the area being preheated.

Monitor the heat generated by welding or preheating, particularly near the area of the seals, by using temperature crayons or probe thermometers. If the heat generated approaches the temperature limit of the seal material, which is indicated on the label, welding should be discontinued or sequenced to another part of the fitting so that the affected area has a chance to cool.

Seal welding the grade B-7 studbolts of the Plidco Split+Sleeve is the most difficult phase of field welding. They are made of AISI 4140 steel with a high carbon equivalence. By using a low hydrogen welding process with preheat, the problem of hydrogen cracking and pinholes can be reduced. The preheat will dry out any moisture, oil dampness or thread lubricant that may be present in the weld area. If the studbolt lengths need to be cut back, allow at least 1/4 inch (6.4 mm) of studbolt beyond the nut for the fillet weld. Preheat the sutdbolt and nut and then weld the nut to the studbolt. Check the preheat and weld the nut to the sidebar.

Welding Sequence

1. Caution should be observed so that welding does not overheat the seals. Sequence the welding so that the heat is not concentrated in one area. It will be necessary to re-torque the studbolts and nuts periodically during field welding because weld contraction causes them to loosen.
2. Fillet weld ends to pipe. (See Figure 2)
3. Seal Weld side openings.
4. Re-torque studbolts and nuts.
5. Seal weld nuts to studbolts.
6. Seal weld nuts to side bars.
7. Seal weld vent plugs, if applicable.

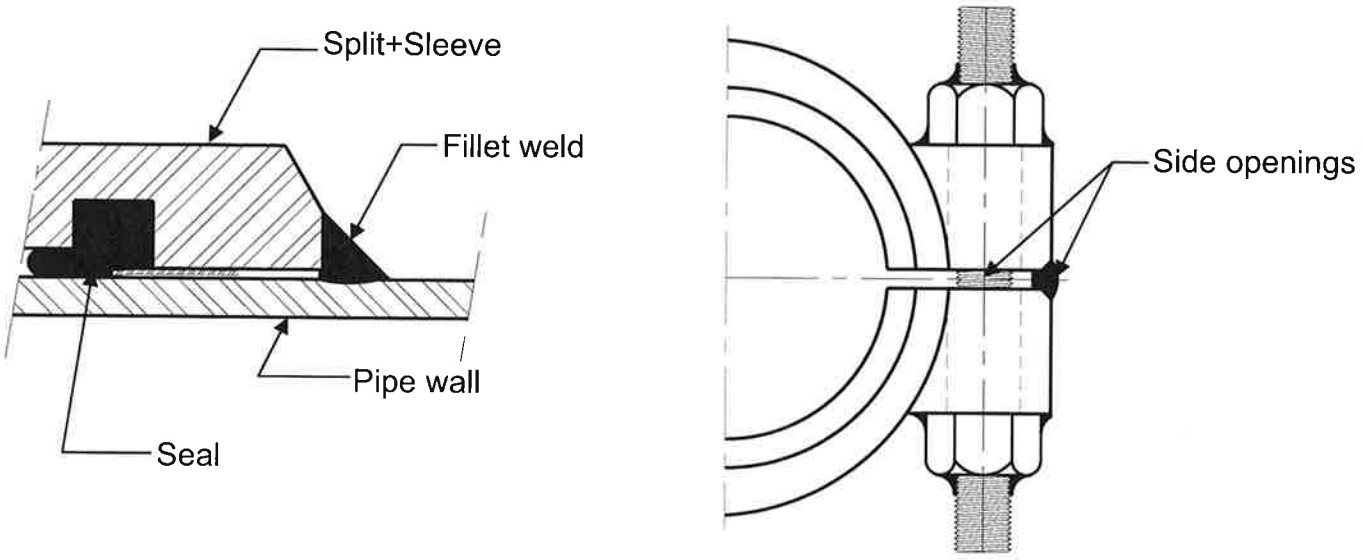


Figure 2

Storage Instructions

Plidco Split+Sleeves should be stored in a dry environment to prevent the unpainted surfaces from rusting. Storage temperatures should not exceed 120°F (49°C). Cover with dark polyethylene to keep the direct sunlight from the packing. It is best to exclude contamination, light, ozones and radiation. Improperly stored Plidco Split+Sleeves can cause the seal material to become cracked and brittle and lose its ability to seal.

Traceability

Plidco Split+Sleeves, as most Plidco products, have a unique serial number by which the fitting is fully traceable. Additionally, all elastomer seals have a unique batch number by which the seal material is traceable.

Underwater Installation

WARNING!

This warning is only applicable to a non-leaking, underwater installation. When assembling a Plidco Split+Sleeve product under water (or under any liquid) it is possible to build up thousands of pounds of pressure in the annulus between the fitting and the pipe. The pressure is caused by compressing the fluid trapped in the annulus as the two fitting halves are closed and tightened. For installations over a leak, pressure in the annulus equalizes with the pressure in the pipe. The pressure trapped in the annulus may have the following effects:

The pressure rating of the split product is exceeded causing leakage or damage to the fitting.

The pipe on which the fitting is installed is damaged.

Personal injury or death due to subsequent removal of a vent plug.

RECOMMENDATIONS

The Pipe Line Development Company strongly recommends the following for non-leaking, underwater installations:

1. All fittings are supplied with vents.
2. Vents are open during installation.

Additionally, the Pipe Line Development Company recommends not using a lubricant on the seals or on the studbolt and nut threads. This is to prevent sand, gravel, or debris from sticking to the lubricant and possibly interfering with sealing and/or obtaining accurate torque reading on the stud bolts. It is recommended that the torque value listed under the 0.15 Cf (coefficient of friction) be used for non-lubricated studs installed underwater.

Plidco Torque Chart

Nominal Diameter of Studbolt (inches) (see Note 2)	Wrench Opening Across Flats (inches)	Torque Values (see Note 1)			
		0.08 C_f		0.15 C_f	
		ft-lbs	Nm	ft-lbs	Nm
		25,000 psi pre-stress			
5/8--11	1-1/16	33	45	56	76
3/4--10	1-1/4	57	77	98	133
7/8--9	1-7/16	91	123	156	212
1--8	1-5/8	135	183	233	316
1-1/8--8	1-13/16	197	267	342	464
1-1/4--8	2	274	372	480	651
1-3/8--8	2-3/16	370	502	651	883
1-1/2--8	2-3/8	485	658	857	1162
1-5/8--8	2-9/16	617	837	1096	1486
1-3/4--8	2-3/4	782	1060	1394	1890
1-7/8--8	2-15/16	968	1313	1730	2346
2--8	3-1/8	1180	1600	2116	2869
2-1/4--8	3-1/2	1695	2298	3053	4140
2-1/2--8	3-7/8	2340	3173	4231	5737
		23,000 psi pre-stress			
2-3/4--8	4-1/4	2880	3904	5224	7083
3--8	4-5/8	3785	5133	6885	9336
3-1/4--8	5	4826	6545	8799	11931
3-1/2--8	5-3/8	6043	8194	11037	14967
3-3/4--8	5-3/4	7447	10099	13626	18477
4--8	6-1/8	9055	12278	16590	22497
		18,800 psi pre-stress			
4-1/4--8	6-1/2	8891	12057	16313	22120
4-1/2--8	6-7/8	10569	14331	19413	26324
4-3/4--8	7-1/4	12444	16874	22882	31028
5--8	7-5/8	14530	19703	26743	36263
5-1/4--8	8	16837	22830	31014	42055
5-1/2--8	8-3/8	19375	26272	35717	48433
5-3/4--8	8-3/4	22156	30044	40873	55425
6--8	9-1/8	25191	34160	46504	63059

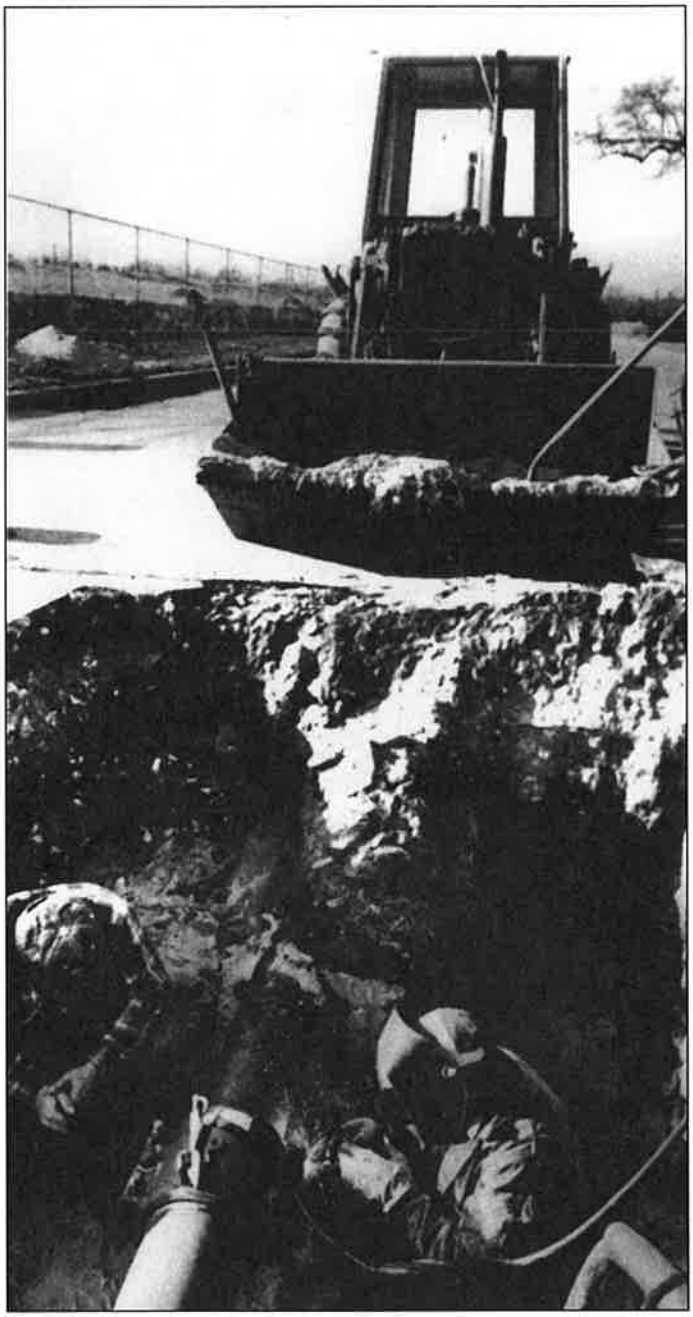
Studs: ASTM A193 Grade B7 - Nuts: ASTM A194 Grade 2H

Note 1: Torque values shown in the table represent two different coefficients of friction (C_f); 0.08 and 0.15. When C_f equals 0.08, it is assumed the studs and nuts are clean, free running, free of obvious flaws and lubricated with a high-grade graphite-oil thread lubricant. When C_f equals 0.15, it is assumed the studs and nuts are clean, free running, free of obvious flaws and lubricated with a light weight machine oil. The torque values are safe minimums and represent approximately the bolt pre-stress values.

Note 2: The second number is the pitch, which is shown in number of threads per inch.

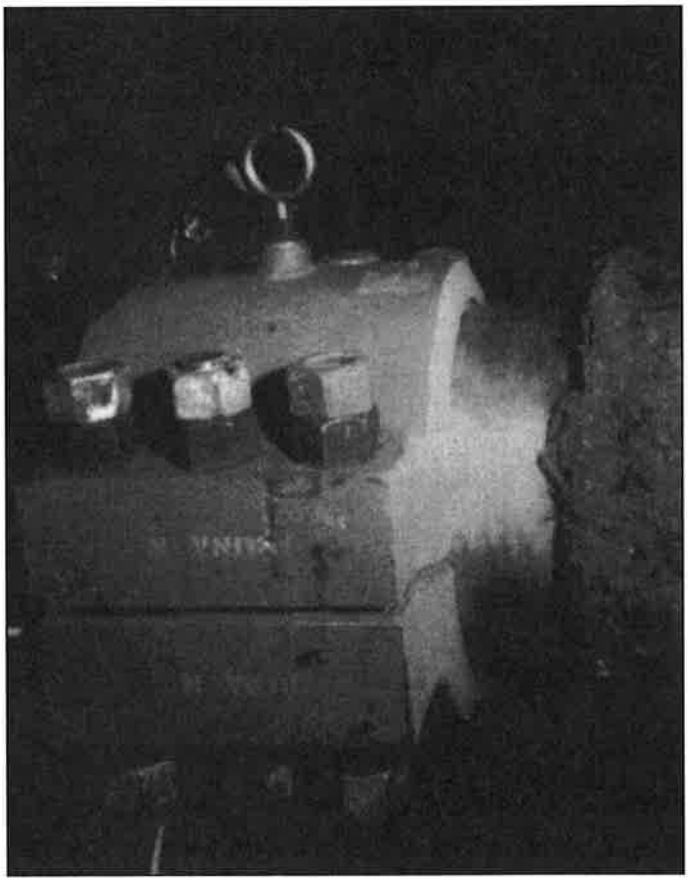
Note 3: Use the pre-stress value shown for the applicable studbolt size if bolt tensioners are to be used and follow the bolt tensioner manufacturer's instructions.

Notes

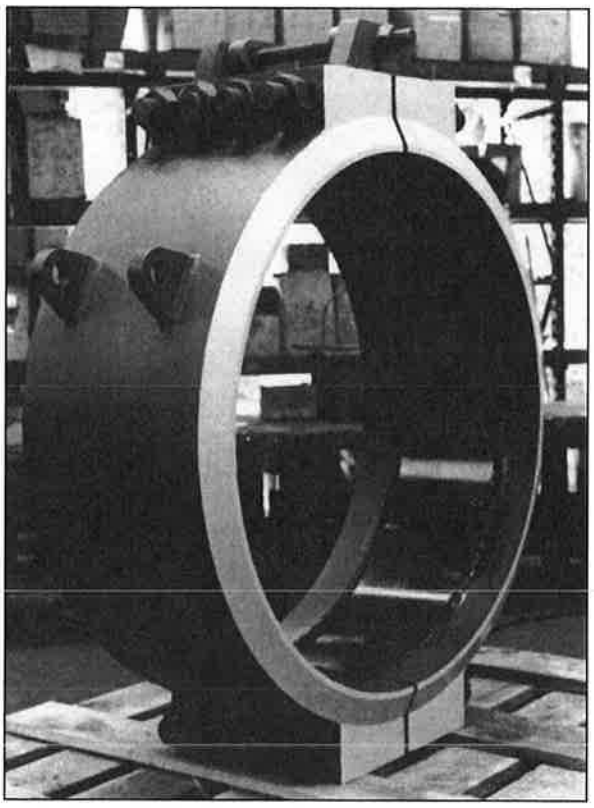


A Plidco Split+Sleeve being installed to repair an underground pipeline that was leaking jet fuel, causing the road to be shut down.

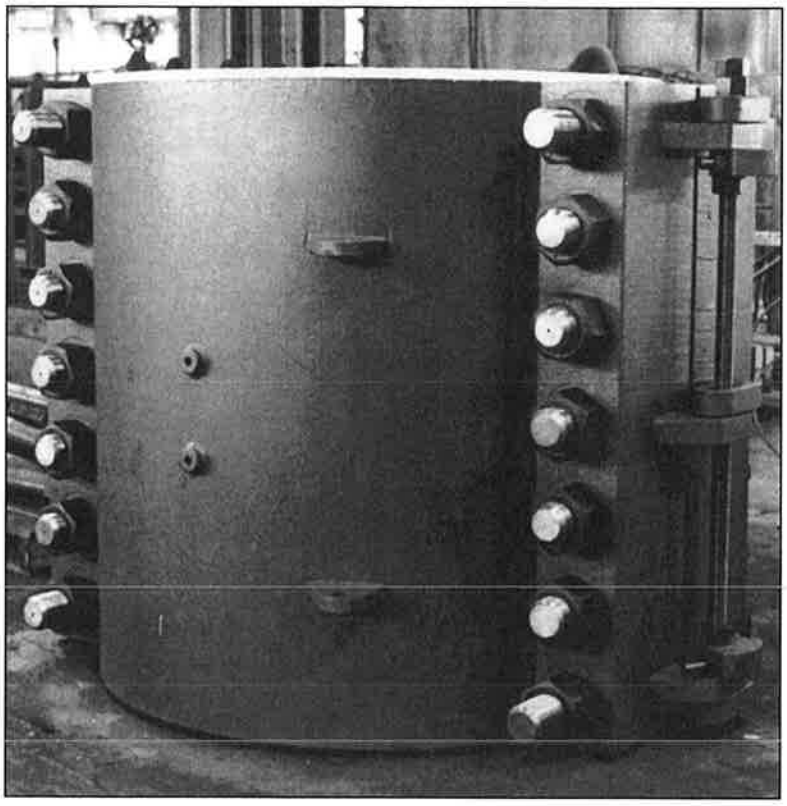
Plidco Split+Sleeves are used for making permanent repairs to a variety of pipelines while the line continues on stream.



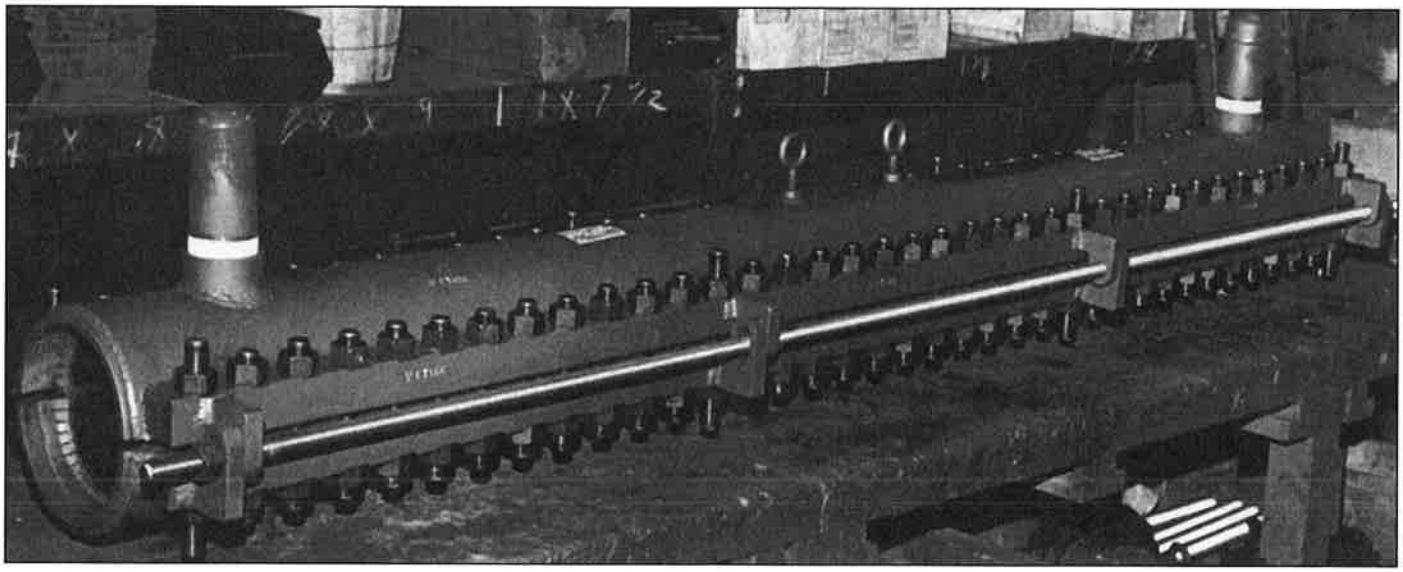
Plidco Split+Sleeve installed on an underwater pipeline in the North Sea.



48" Plidco Split+Sleeve for repair of Alyeska Pipelne designed for 1200 psig working pressure.

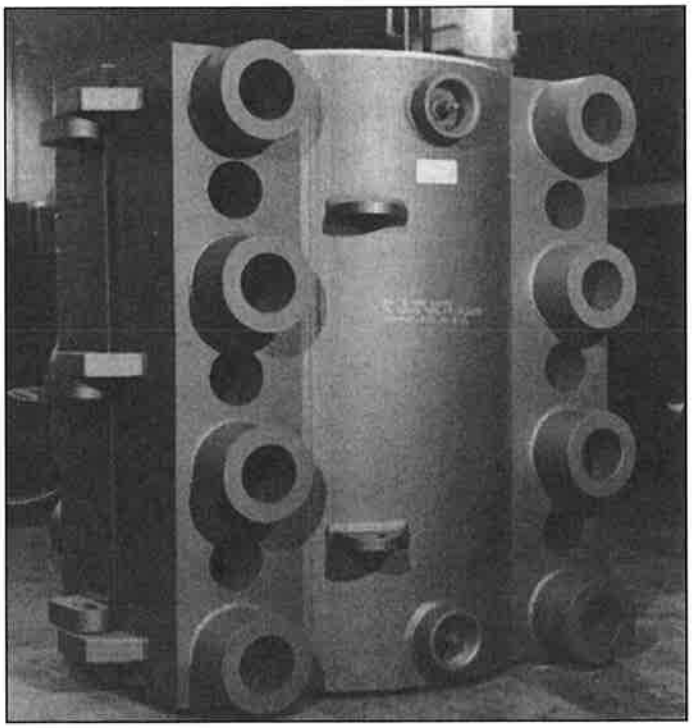


46" x 54" long Plidco Split+Sleeve designed for 1000 psig working pressure.

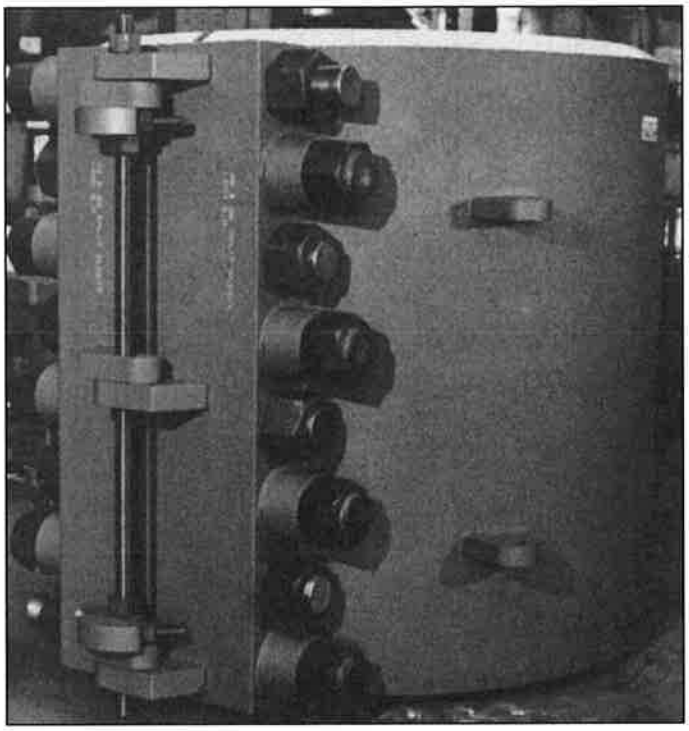


8" x 114" Extra-Long Special Plidco Split+Sleeve used for repair of an underwater pipeline. Hinges were provided to simplify the installation. The fitting was designed, fabricated, tested and shipped in 4 days after receipt of specifications by telephone.

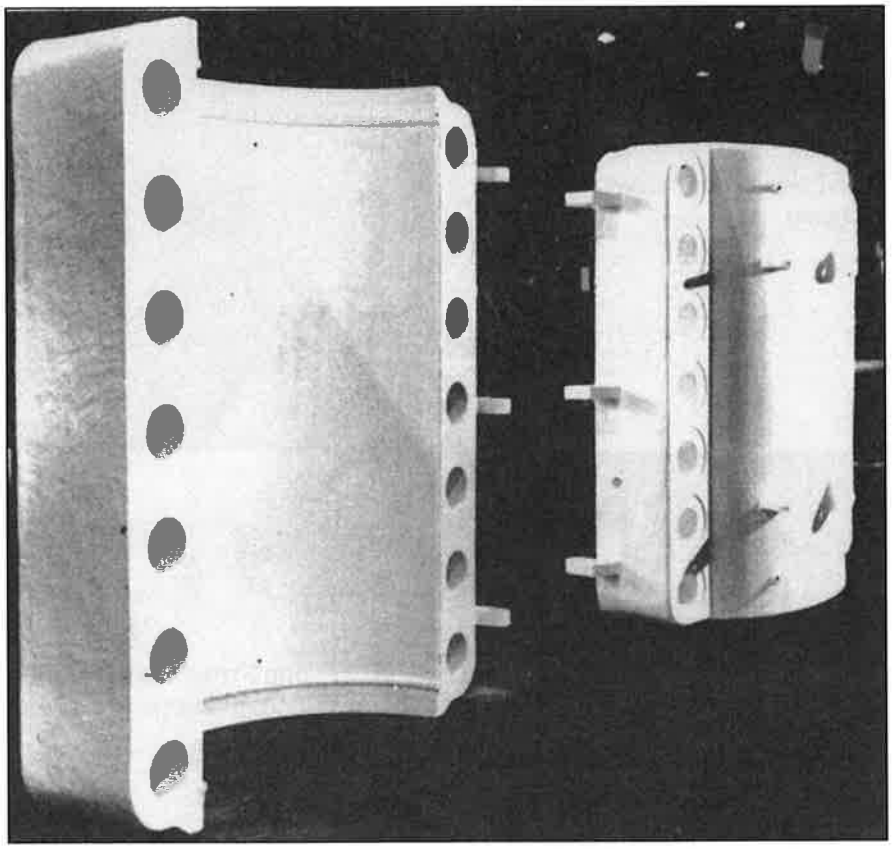
The longest Plidco Split+Sleeve made to date is 20 feet long, used for underwater repair on a 12" diameter pipe.



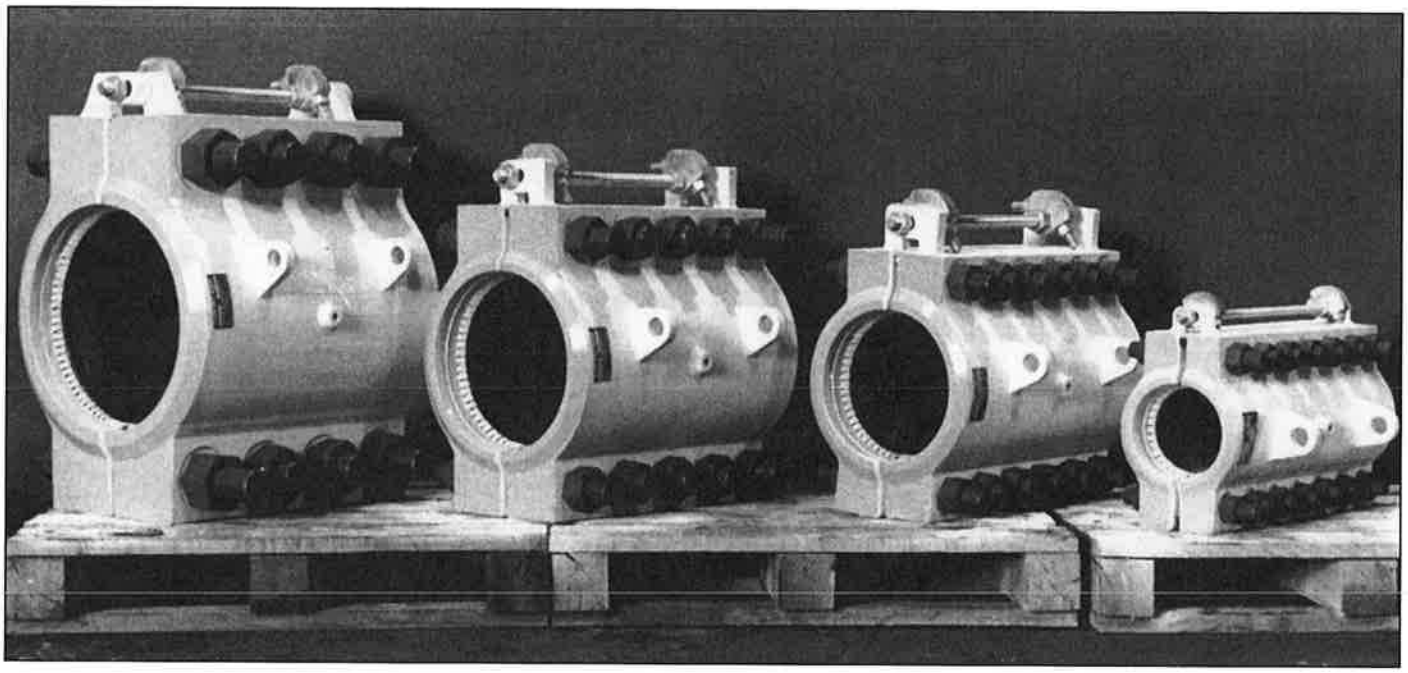
24" x 54" long Plidco Split+Sleeve, designed for 3000 psig working pressure.



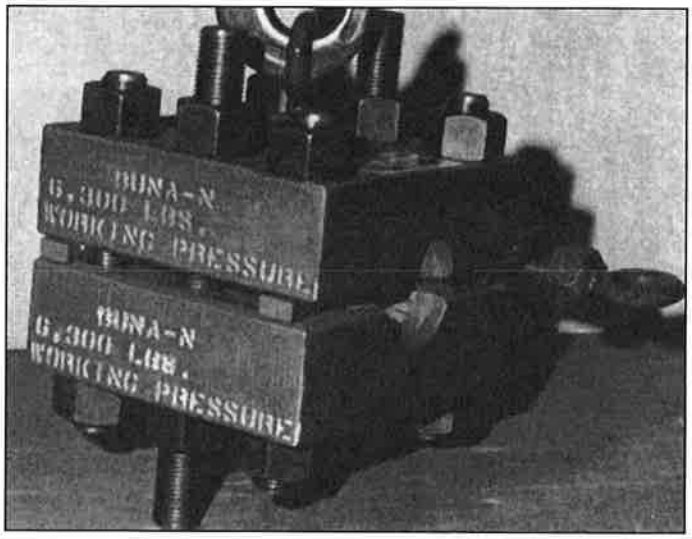
48" x 56" long Plidco Split+Sleeve, designed for 1200 psig working pressure.



48" x 80" long Plidco Split+Sleeve, designed for 1440 psig working pressure, for installation offshore in the Gulf of Mexico.

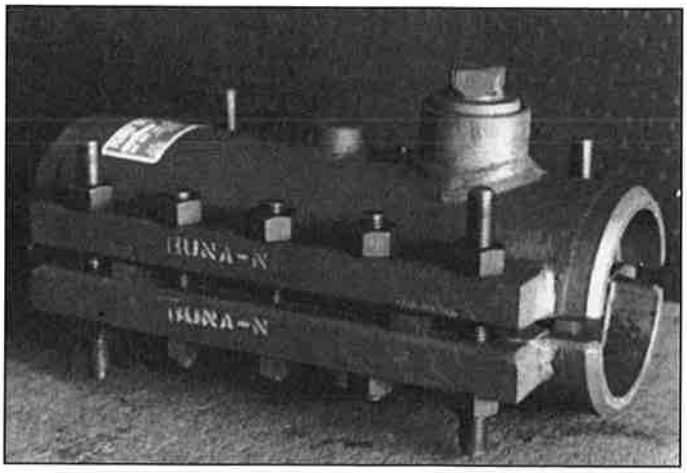


16", 12", 10" and 6" Plidco Split+Sleeve, 24" long, designed for 2000 psig working pressure, equipped with hinges for easier installation offshore.



Special 2" Plidco Split+Sleeve, designed for 6300 psig working pressure.

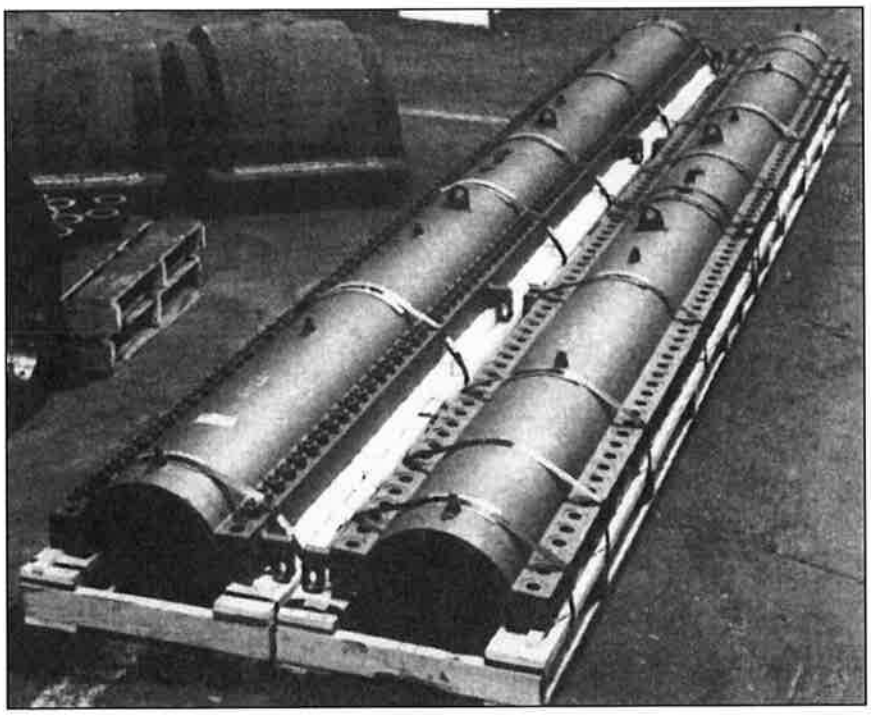
Plidco Split+Sleeves have been produced with working pressures up to 15,000 psig.



4" X 18" long Plidco Split+Sleeve with a 2" vent. Vents and buttonhead fittings are available on application.

PLIDCO®

SPLIT+SLEEVE



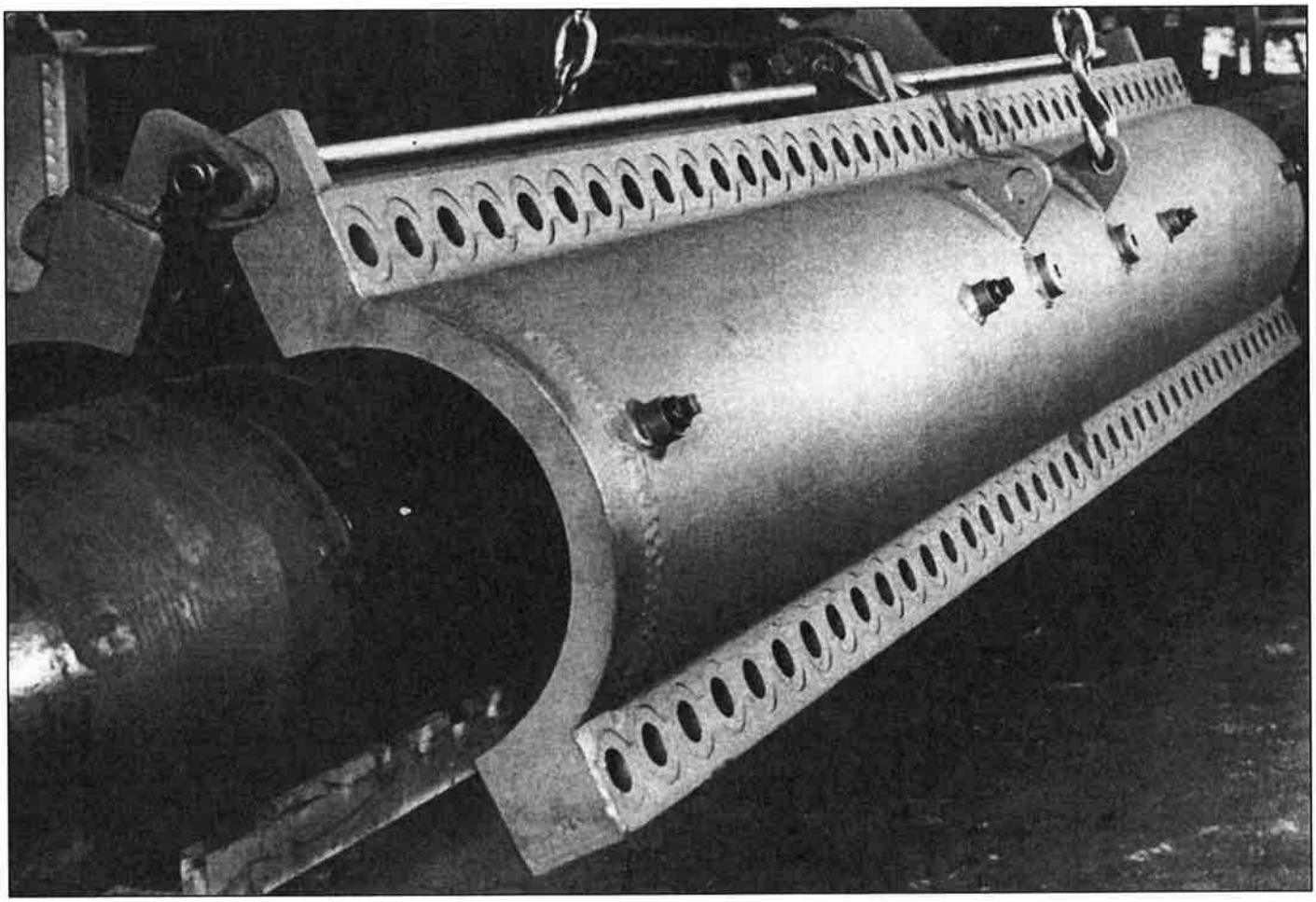
The longest Plidco Split+Sleeves made were installed off the coast of California for repair of underwater pipelines damaged by corrosion.

The Plidco Split+Sleeves were desjgned for 1000 psig working pressure and measured 10 feet, 15 feet and 20 feet long.

For easier installation, nuts were welded to the side bar on one half of each sleeve and to the studs.

Hinges were provided to assist the divers during installation.

12" x 20 ft. long Plidco Split+Sleeve



12" x 10 ft. long Plidco Split+Sleeve

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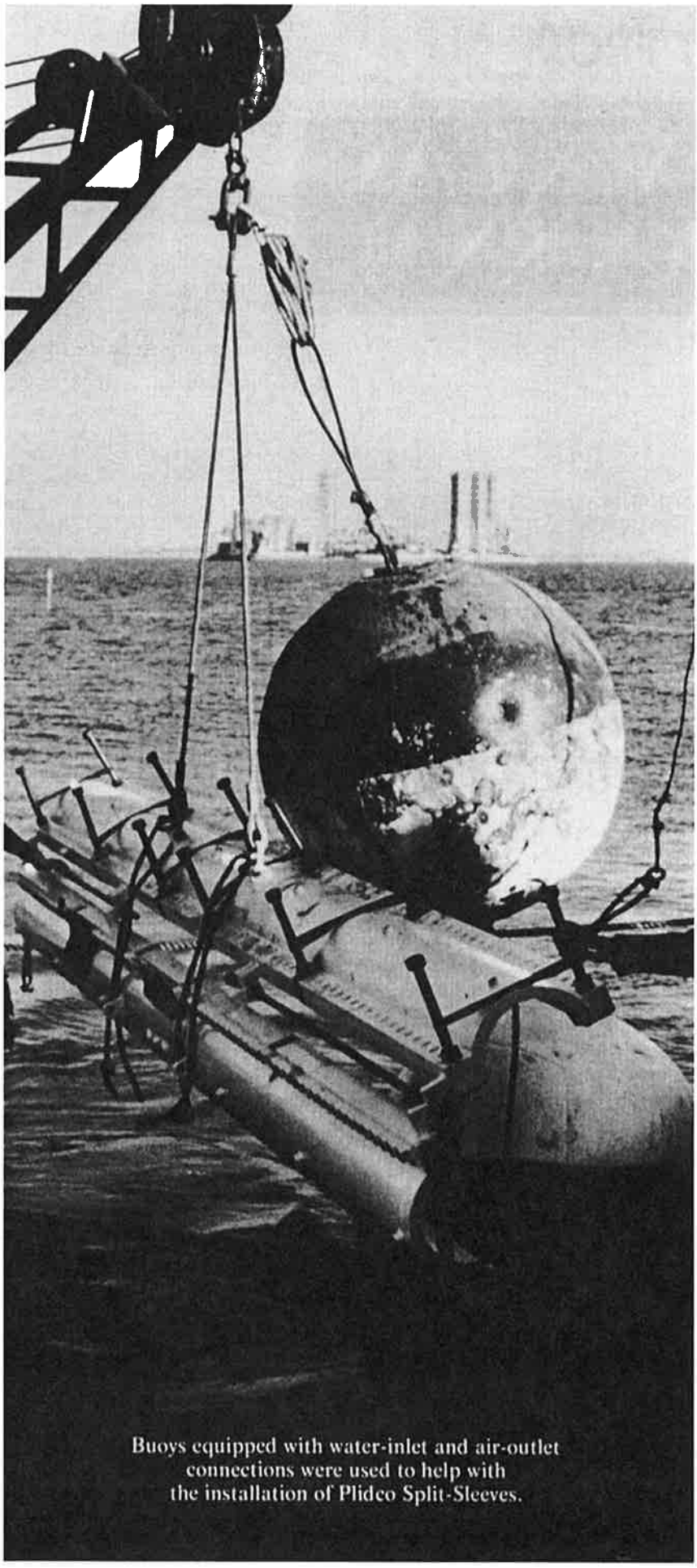
OIL & GAS JOURNAL

A report on the use of

PLIDCO SPLIT-SLEEVES

For restoring underwater pipelines



Buoys equipped with water-inlet and air-outlet connections were used to help with the installation of Plidco Split-Sleeves.

Split

W. F. Ellison
R. D. Robuck
Thums Long Beach Co.
Long Beach, Calif.

Thums Long Beach Co. restored the subsea pipelines of its Long Beach Unit at points where surveys indicated thinning due to corrosion. Permanent repairs were made using bolted, split sleeves at 10 points along the offshore system (Fig. 1).

These lines were installed originally using the lay-barge method in 1966-67. Joints were metallurgically inspected, 100% X-rayed, and hydrostatically tested. But despite a chemical-inhibition program and cathodic protection, corrosion was found to be a problem.

From the beginning, there has been great concern in regard to protecting the environment. An oil spill at this site would endanger one of the nation's finest beach areas.

In late 1975, work began to install bolted, split sleeves over each point selected for repair. By the end of March this year, all work had been finished at a cost of $980,000.

Operation. Thums Long Beach Co. is an agent for the field contractor, Texaco, Humble (now Exxon), Union, Mobil, and Shell. It furnishes the operating services for the city of Long Beach, unit operator for the Long Beach Unit in the East Wilmington field.

The approximately 400,000 b/d of gross fluids are collected through the pipeline system. The system links the four man-made islands in the San Pedro Bay, less than 1 mile offshore from the City of Long Beach, Calif., with onshore treating facilities.

The buried pipeline system consists of 30 miles of 6, 8, 12, and 14-in. pipe buried 7 to 15 ft beneath the bottom in 30 to 40 ft of water. All

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sleeves reinforce subsea lines

lines are externally somastic coated for corrosion protection. The larger lines are weighted with 1½ to 2 in. of reinforced concrete coating.

Entire pipeline network is externally protected with an impressed-current cathodic system. Additionally, pipeline-scraper facilities were installed to scrape the lines weekly.

Repair method. Philosophy for repair of the pipelines was to provide permanent and complete repair of selected portions of the submarine pipelines. In addition, uninterrupted operation of the pipeline was required.

These considerations led to selecting the split-sleeve clamps to be used for repairs. Replacing affected areas or installing underwater weldments would have been costly.

Repairs using bolted-sleeve couplings may be made at any depth suitable for diving operations. So, special underwater welding habitats are not required.

The pipeline need not be taken out of service except for internal logging and pressurizing the line to prevent its collapse during injection of sealing material.

To assure the permanence of bolted sleeves, several requirements were set:

- Viton elastomer seals were installed between sleeve halves and ends. This was for protection from exposure to pipeline fluids should a hole occur in the pipeline after the sleeves were installed.
- The annular space between the outside of the pipe and the inside of the sleeve was filled with an inert material. This would bond to all surfaces and protect the seals and sleeve against corrosive pipeline fluids.
- All external steel surfaces of the assembly, including hardware and bare pipe, were coated with an underwater-applied coating.
- External cathodic protection was provided in the repair assembly area.

Organizing resources. Few contractors were experienced in all phases of repair work on buried submarine pipelines in depths and operating conditions similar to those in Long Beach. So, Thums assumed the role of general contractor for the project. In addition, it provided a work barge by converting a cargo bargo from its marine fleet (Fig. 2).

Diving and other specialized services were furnished through subcontractors. Control of costs and the ability to be flexible in the ongoing planning and operations stages resulted in savings over the general contract approach.

Close coordination between repair

Fig. 1

Location of submarine pipeline repairs

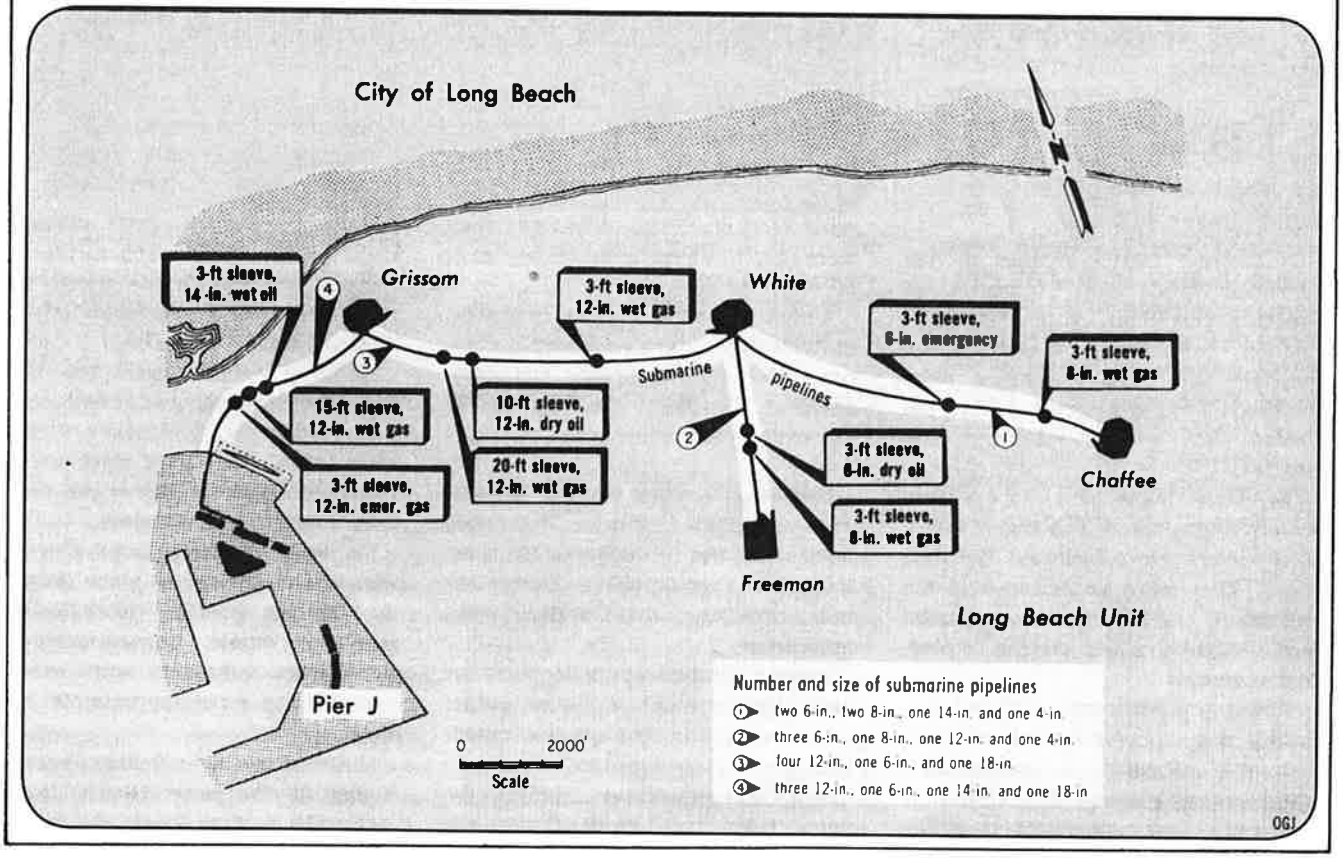
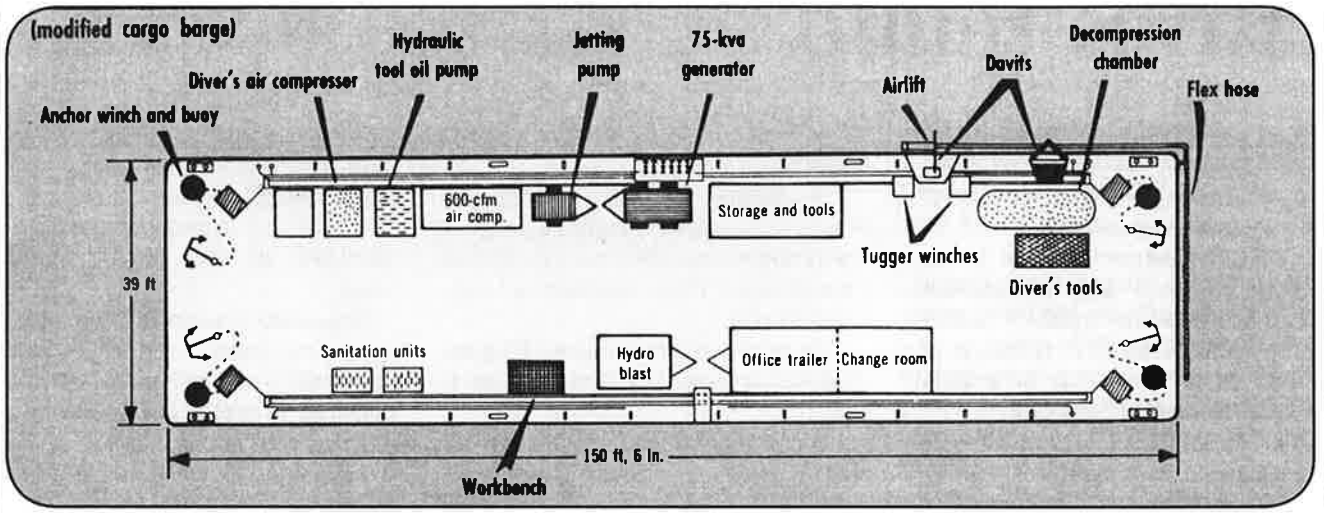


Fig. 2

Work-barge layout



work and producing activities reduced costly production delays.

A project team was formed from Thums engineering and operations staff (Fig. 3). The project team had many years of accumulated experience to apply to this project.

A former retired engineer was retained to apply his specific experience with the original construction of the subsea pipelines. The project was assigned a high priority within the purchasing department. And weekly delivery-status reports of critical materials were furnished to the project superintendent.

Daily costs were kept by accounting people and noted on the daily-progress report. This information helped management and the project team to maintain close cost control.

A contract marine-weather service provided local daily forecasts of weather conditions. With this information contingency planning was possible and standby charges were reduced. Surveying services were obtained from a local surveying contractor.

Available diving services were carefully evaluated, and highly qualified divers were selected for the work. They were experienced in the operation of underwater equipment and the handling and placing of pipe-repair sleeves.

Before any work was done, all materials and equipment were inventoried and inspected. A maintenance mechanic was assigned full time to the work barge to maintain equipment during the course of the project. Major rental equipment was serviced by the rental agency during slack work periods.

Inspecting with television. Until recently, only second-hand accounts reported by construction and maintenance inspectors were available. With underwater television equipment, it is now possible to obtain a continuous, live, audio-visual account of work as it progresses.

Equipment is mounted in a plastic diving helmet. This affords the remote viewer an even better degree of optical resolution than that observed by the diver.

A continuous videotape record was made of critical operations. Inspectors and project coordinators had the benefit of monitoring underwater work as it was being done. And they were able to direct more closely each phase of the work.

Within a short time after recording, the videotapes were reviewed in company offices by engineers and management. The tapes are kept on file as documentary evidence of the work done.

Dredging. At first, a 6-in. suction dredge equipped with a 75-ft rigid ladder was used to uncover the pipelines at the repair points. During the initial dredging, three serious problems arose.

Dredge flotation was inadequate for safe operation with a 2½-ton ladder when working in 30 to 40 ft of water with waves exceeding 1 to 2 ft.

When the water was choppy, the vertical movement of the dredge and heavy ladder presented a chance for possible damage to the subsea pipelines. And the 6-in. suction line was found to be too small for adequate progress.

The dredge was modified by adding a shorter 8-in., lightweight pipe ladder and 40 ft of flexible 8-in. suction hose. A diver-operated jetting nozzle was attached to the hose.

Although this configuration required continuous attention of a diver, it proved to be a good, safe method to remove underwater overburden from the lines. Another plus for this method was that the diver could control the size and depth of the excavation to meet minimum requirements.

Where a steep angle was hard to maintain, loose materials collecting in the excavation were removed with a 12-in. airlift. The airlift also reduced turbidity in the repair area permitting better visibility for the divers and the TV monitor.

Locating repair points. The internal pipeline-survey tool could accurately locate the weld joints. But, in most cases, the joints were too far from the point of repair to accurately locate the repair areas.

To keep dredging costs down, a plan was developed to place magnets as near as possible to calculated points of repair. Conventional surface-survey techniques were used to establish these approximate locations.

Since up to six pipelines were installed in the same trench, it was necessary to first locate the pipeline on which repairs were to be made.

Fig. 3

Organization chart

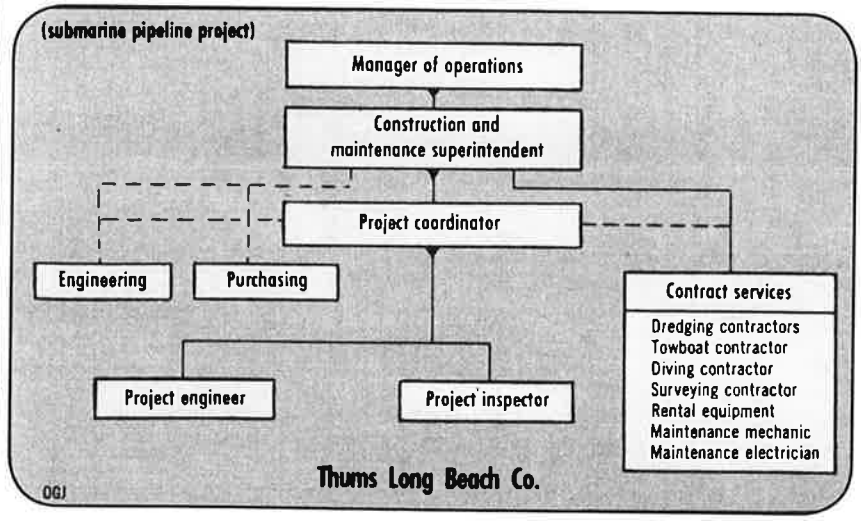
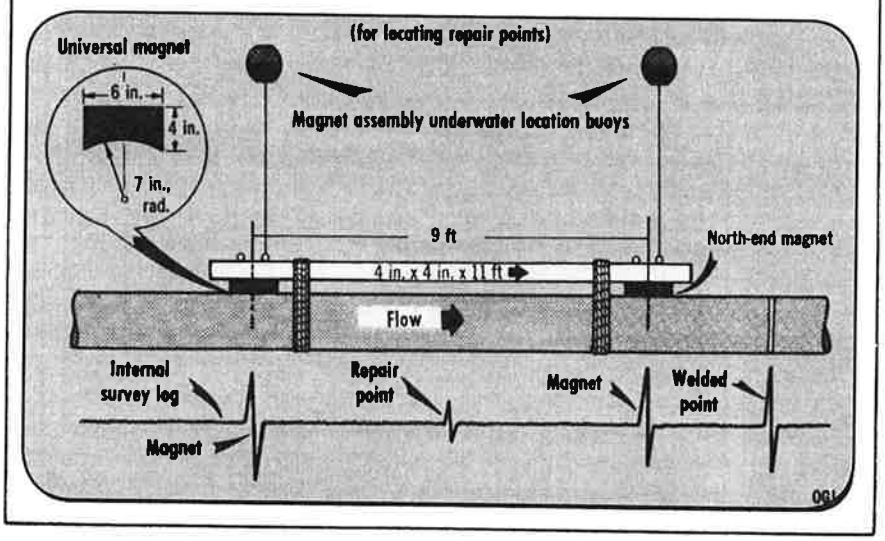


Fig. 4

Typical magnet installation



This was done using an electronic pipe-detection device that identified a signal introduced into the pipe from a point on shore.

Initial dredging then permitted the pipe to be uncovered at the location thus established.

An 8-in. rectangular window was then cut in the concrete-weight coating. Then a special magnet was fixed to the pipe in a manner that would prevent damage to the underlying somastic coating.

The permanent magnets provided a minimum of 550 gauss at the inside surface of the pipe. Positioning two magnets exactly 9 ft apart permitted a calculation of the proximity of the magnets to the repair point by direct proportion (Fig. 4).

In some cases, the magnet assembly was placed close enough on the first try to fix the repair point between the two magnets. In each case, before the actual placement of a repair sleeve, a relocation of magnets was made. Then an internal survey was made to verify the relative location of the repair point with respect to magnet locations.

Dredging costs were greatly reduced by using this technique to accurately position the repair clamps.

After completing all repair work and before backfill, a final internal pipe survey was made. This furnished a permanent record of the actual sleeve location in relation to the corroded areas (Fig. 5).

Preparation for sleeves. The safest and most-economical methods to remove the ¾-in. somastic coating and 1½-in. concrete-weight coating covering the pipe had to be developed.

Hand-held jackhammers, air-operated diamond saws, and other hand-tool methods were considered. Each of these had serious limitations, including potential damage of the pipe during removal of the coatings; and the slow and costly progress of this phase of the work.

The method finally developed and used, after underwater tests, was high pressure hydroblasting.

Equipment is fitted with a counterforce "T" nozzle. With it, a diver can remove all of the concrete and most of the somastic coating over a 5-ft length of pipe in less than 2 hr. Water pressures run to 10,000 psi.

Final cleaning of the pipe was done with underwater sandblasting using a conventional compressor and sand hopper. Using this technique, the pipe was cleaned to a near bright-metal condition.

The diver, equipped with a helmet video-camera, transmitted a clear complete picture of all operations to the inspector located on the work barge. In some instances, these inspections after cleaning revealed evidence of external corrosion.

Installing sleeves. Several repair sites involved multiple repair points in close proximity along the length of the pipe.

A cost study was made to compare the cost of placing multiple short sleeves with the cost of single long sleeves. These calculations indicated the multiple repair points could be covered more economically by 10, 15, or 20-ft sleeves.

Handling of the long, heavy sleeves during installation posed a problem. Weight of the 20-ft sleeve is about 6,500 lb. This is in excess of the load capacity of the tugger-winch hoist used to install the smaller sleeves.

To solve this problem, flotation was designed using 5-ft-diameter crown buoys equipped with a water-inlet and air-outlet connection for flooding (Fig. 6). The sleeve was placed in the water and attached by a sling to the crown buoys.

Guide wires attached to the pipe at each end of the repair area were connected through eyes to both ends of the sleeve. This provided stability during lowering. The buoys were floated by the diver until there was

Fig. 5

Typical record log

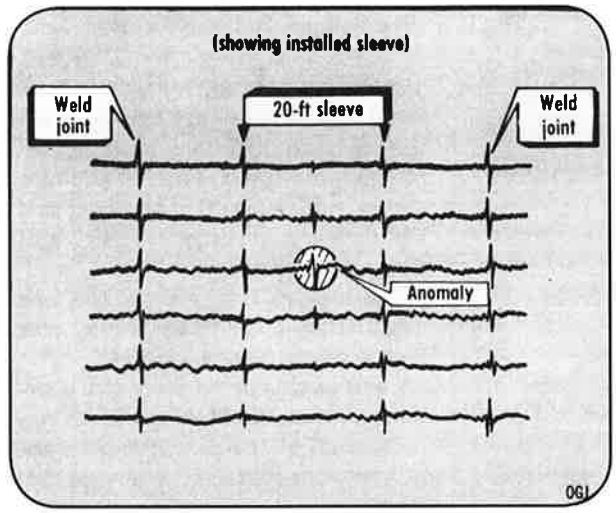


Fig. 6

Rigging for placing repair sleeves

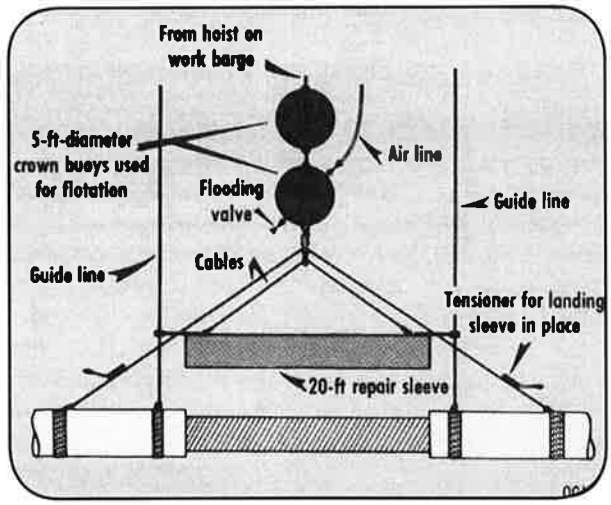


Fig. 7

Cross section: protective coatings

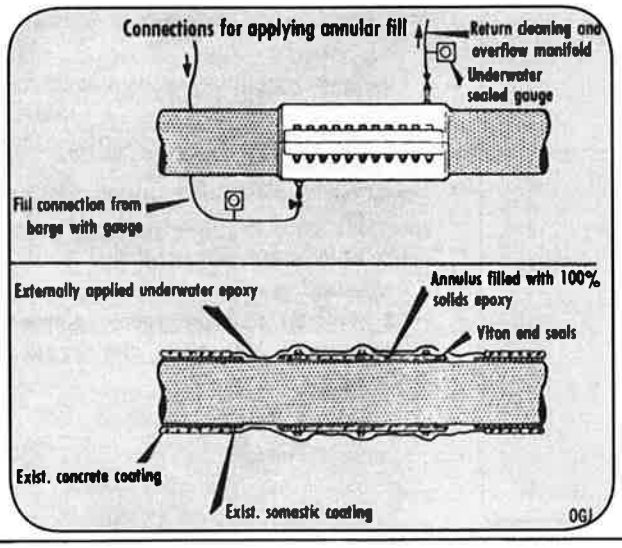
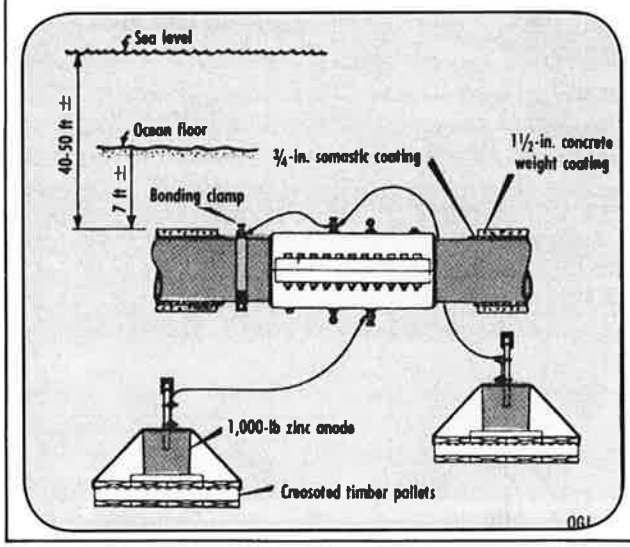


Fig. 8

Sleeve and anode installation



only a slight positive buoyancy.

The sleeve was then pulled down onto the pipe and final positioning was controlled by diver, hand-operated ratchet tensioners. This procedure was used rather than lowering the sleeve under negative buoyancy to prevent damage to the seals upon mating the sleeve with the pipe.

Sealing the annulus. A 100% solids content epoxy filler material was used to seal the annular space. This material meets viscosity and thermal setting conditions with the corresponding dimensions of the hydraulic system and temperatures of the water and pipeline.

The annular space was purged with air and alcohol to absorb latent moisture and finally with nitrogen before injecting epoxy.

A dual drum pumping system with a two-part proportional mixing manifold was used to pump epoxy to a small reservoir. There, it was picked up by a high-pressure positive-displacement pump and transferred through high-pressure hoses to the underwater sleeve (Fig. 7).

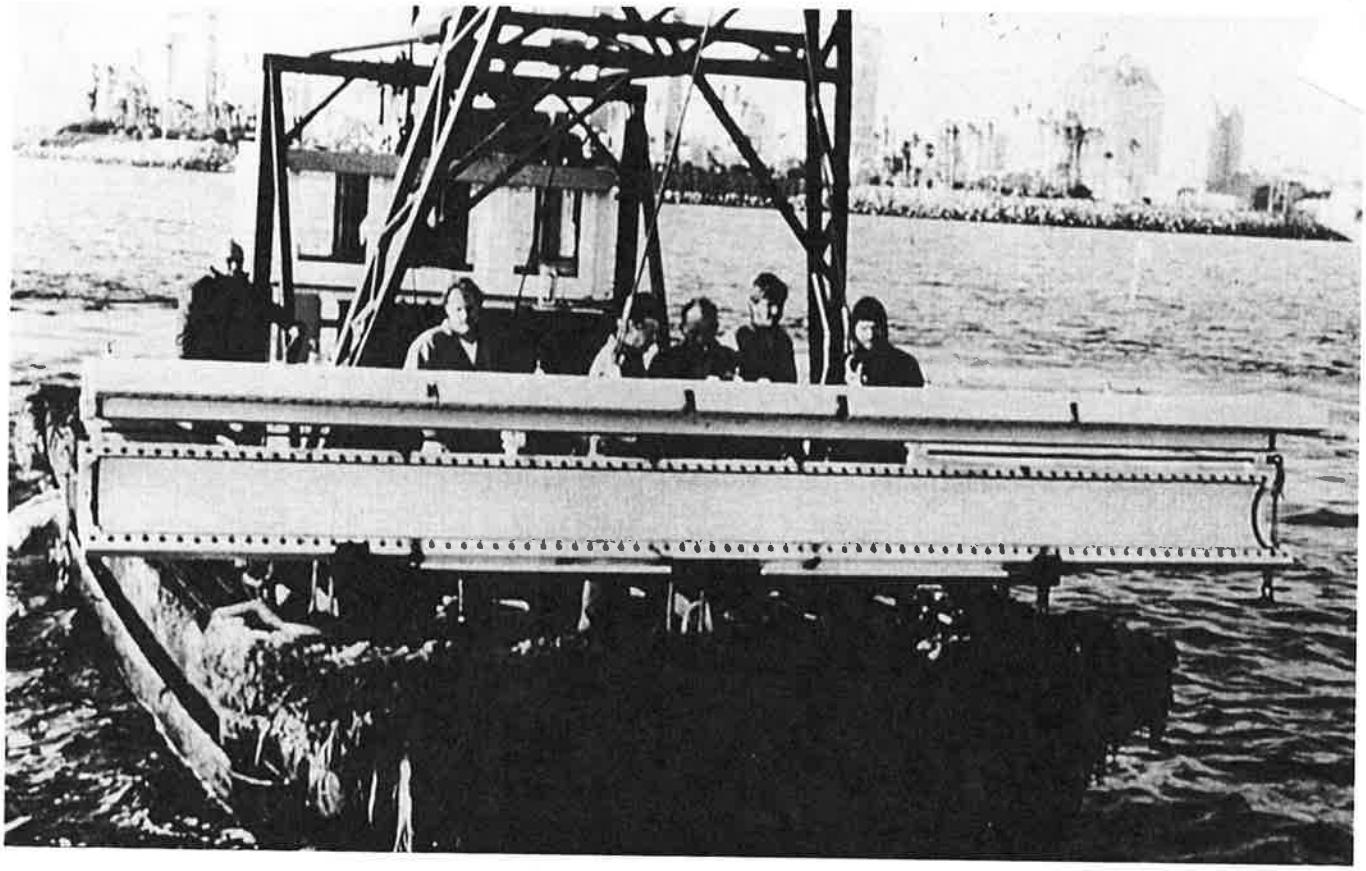
Sleeve inlet and outlet pressures were maintained throughout the injection process. Full stream returns were observed for several minutes after calculated fill-up of the system.

Before placement, all of the internal and external surfaces of repair sleeves were coated with a baked-on epoxy coating. This was done to reduce the possibility of corrosion of the assembly in undersea service.

After installation and internal sealing of the annular space, the entire external assembly was coated with a hand-applied underwater epoxy (Fig. 7). The bare pipe surface adjacent to the assembly was also coated.

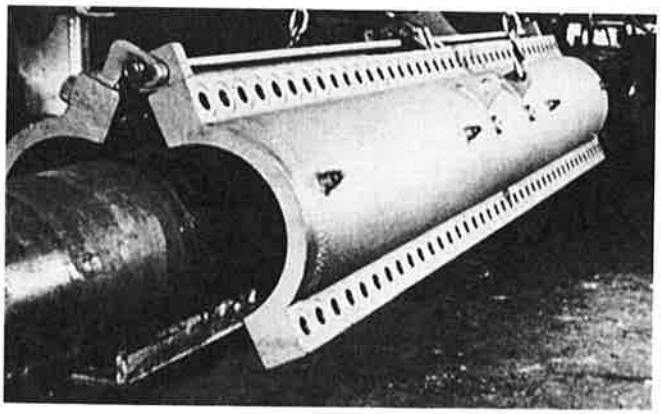
All coated surfaces were covered with a 6-in.-wide fiber-glass wrapping as this portion of the work progressed. This was done to prevent sagging or dislodgement of the underwater epoxy material before a permanent set of the material.

Design of the underwater assembly provided for the attachment of two 1,000-lb zinc anodes (Fig. 8). To obtain a 30-year maximum life for these sacrificial anodes, they were built in a cube configuration with a low surface area. END



Plidco Split+Sleeves help Thums Long Beach Company restore its pipelines

The longest Plidco Split+Sleeves ever made for underwater repair of pipelines damaged by corrosion were installed by Thums Long Beach Company in the Long Beach Unit of the East Wilmington, California Field.



Plidco Split+Sleeves were equipped with hinges for easier installation.

Designed for 1000 psi working pressure, these Plidco Split+Sleeves measured 3 ft, 10 ft, 15 ft, and one extra long unit of 20 ft. They were used for repair without taking pipelines out of service, except for internal logging and pressurizing of the line to prevent its collapse during injection of sealant material.

Each Split+Sleeve incorporated Plidco's patented steel GirderRings that hold gaskets in place to prevent displacement during installation. Hinges were provided to assist divers with the installation.

Plidco Split+Sleeves are available in standard sizes and lengths from stock. Higher working pressures, special lengths and sizes are available on application. Write or call for catalog — 440-871-5700.

SPECIFY THE PRODUCT WITH THE PLUS

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PLIDCO® CLAMP+SLEEVE

Couples pipe, seals leaks, & reinforces damaged pipe

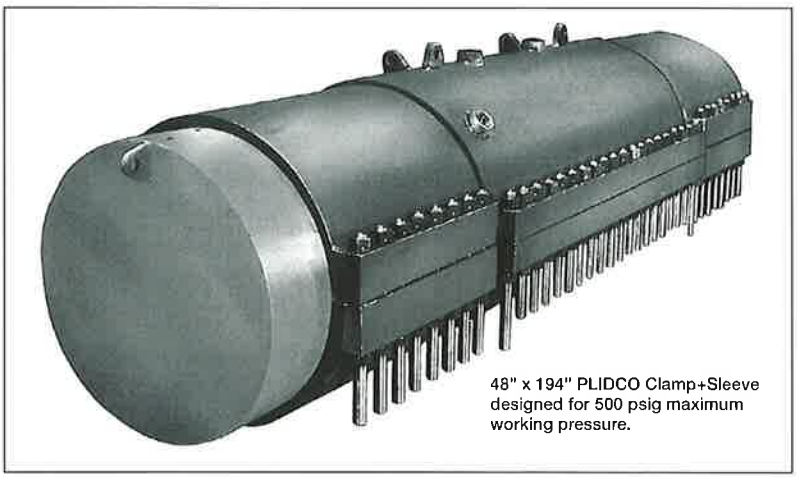
PLIDCO® Clamp+Sleeve grips the outside wall of a pipe to counteract extraordinary end-pull and unusual axial stresses often encountered in off-shore installations. PLIDCO® Clamp+Sleeves provide exceptional holding power minimizing the danger of caving in damaged pipe. Patented steel GirderRings hold the packing securely in place during installation, assuring a gas tight, liquid tight seal. PLIDCO® Clamp+Sleeves are available in any size, length and working pressure. They can be designed for welding or non-welding applications. The sleeve can be reconditioned and used again if not welded. The Plidco® Clamp+Sleeve is designed to ASME code section VIII and API 6H.

Buna-N packing is standard.
Viton, Silicone and other packings are available upon request.

Standard body materials:
- ASTM A106 Gr. C
- ASTM A216 Gr. WCC
- ASTM A516 Gr. 70
- Standard bolting is ASTM A193 Br. B7 with ASTM A194 Gr. 2H nuts

Options:
- Marine epoxy paint for corrosion protection
- Hinges for ease of installation and handling
- Vents per customer specifications
- Anodes for cathodic protection
- NACE MR0175 / ISO 15156 compliant materials
- ASME 31.3

Patented



48" x 194" PLIDCO Clamp+Sleeve designed for 500 psig maximum working pressure.

PIP053

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PLIDCO® CLAMP+SLEEVE INSTALLATION INSTRUCTIONS

!! WARNING !!

IMPROPER SELECTION OR USE OF THIS PRODUCT CAN RESULT IN EXPLOSION, FIRE, DEATH, PERSONAL INJURY, PROPERTY DAMAGE OR HARM TO THE ENVIRONMENT.

Do not use or select a Plidco Clamp+Sleeve until all aspects of the application are thoroughly analyzed. Do not use the Plidco Clamp+Sleeve until you read and understand these installation instructions.

Every effort has been made to securely package this product prior to shipment. If you have any questions, or encounter any difficulties using this product, please contact:

PLIDCO "DEPARTMENT 100" at 440-871-5700
toll free U.S. & Canada 800-848-3333

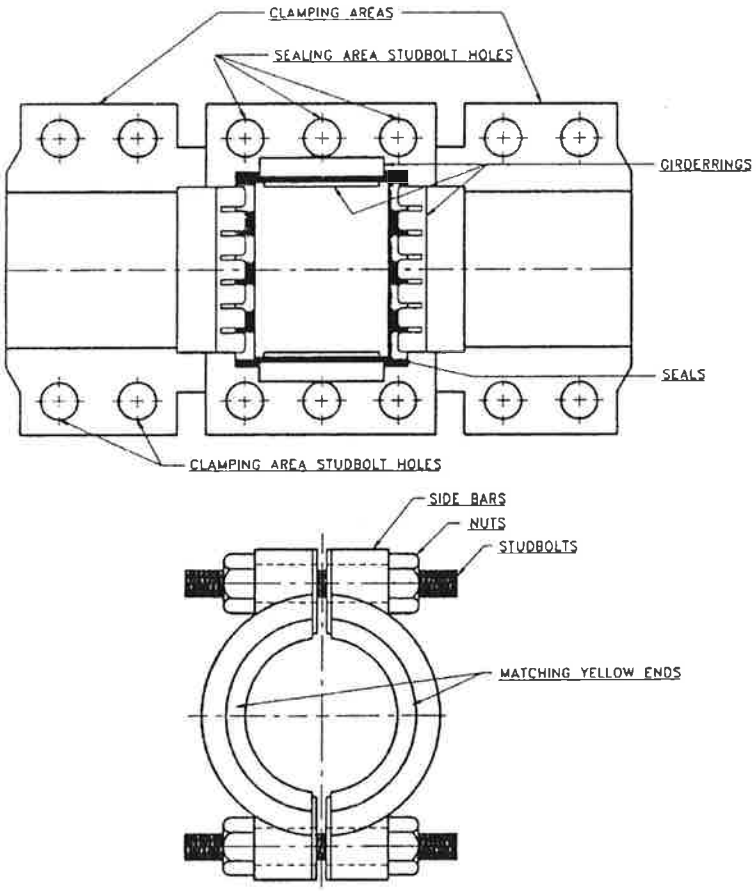
READ CAREFULLY

The person in charge of the installation must be familiar with these instructions and communicate them to all personnel involved.

SAFETY CHECK LIST

- ❑ Read and follow these instructions carefully. Follow your company's safety policy and applicable codes and standards.
- ❑ Be absolutely certain that the correct seal material has been selected for the intended use.
- ❑ A Plidco Clamp+Sleeve may be used to join pipe ends. Verify the end restraint is sufficient to the resist hydrostatic and, if applicable, dynamic and external forces such as thermal induced forces.
- ❑ Observe working pressure and temperature on the label of the Plidco Clamp+Sleeve. Do not exceed maximum working pressure or temperature as indicated on the unit.
- ❑ Verify the tightness of any threaded vents and connections.
- ❑ When repairing an active leak, extreme care must be taken to guard personnel. Severe injury or death could result.
- ❑ When installing a Plidco Clamp+Sleeve on a non leaking pipe submerged under water (or any liquid), Plidco strongly recommends the vents be open during installation to prevent excessive pressure buildup within the fitting due to hydraulic lock.
- ❑ If the pipeline has been shut down, repressuring should be done with extreme caution. Repressuring should be accomplished slowly and steadily without surges which could vibrate the pipeline and fitting. Industry codes and standards are a good source of information on this subject. Do not exceed maximum working pressure. Personnel should not be allowed near the installation until the seal has been proven.

CLAMP+SLEEVE COMPONENTS



PIPE PREPARATION

1. Remove all coatings, rust and scale from the pipe surface where the circumferential seals and clamping sections of the Plidco Clamp+Sleeve will contact the pipe. The seals can tolerate minor surface irregularities up to ± 1/32".
2. Survey the outside of the pipe to confirm a circular cross section, particularly in the area of the circumferential seals. This area should be a smooth curved surface without indentations or flat spots that could adversely affect proper sealing.
3. A ring gauge should be used for submerged pipelines where visibility is limited. Plidco has available ring gauges that can accurately survey the cross sectional shape of the pipe. Information is available upon request.
4. The bolting force generated when assembling the two halves is capable of reshaping minor out-of-round pipe. Maximum allowable ovallity is approximately 5%, depending on the pipe wall thickness. Flat spots are very difficult to reshape and the bolting force should not be relied on to reshape the pipe.
5. If the Plidco Clamp+Sleeve is being used to join pipe ends, the allowable gap between the pipe ends is dependent on the internal length between circumferential seal. The pipe ends must extend past the circumferential seals by at least 1½ inches. A standard Plidco Clamp+Sleeve has a straight bore which does not allow for angular misalignment of the two pipe ends.
6. Clean and lubricate all Plidco Clamp+Sleeve stud bolts and nuts. Prove free and easy nut running prior to installation.
7. Coat all exposed surfaces of the sealing material with a lubricant. The following chart indicates the lubricants that are recommended and the maximum temperature limit for the various seals. The customer must determine if the lubricant is compatible with the product in the pipeline.

Buna-N	A, B, C	225°F
Viton	A, B, C	250°F
Silicone	C	450°F
Neoprene	B, C	250°F
Aflas	A, B, C	250°F
Teflon	A, B, C	500°F
Kevlar	A, B, C	750°F

A	petroleum based lubricant
B	silicone based lubricant
C	glycerin based lubricant

INSTALLATION

The seals and GirderRings can be damaged by careless handling. Lifting devices such as chains, cables or lift truck forks should not contact the seals or GirderRings. Contact can result in the seals being pulled from their grooves.

1. Assemble the Plidco Clamp+Sleeve around the pipe making certain the yellow painted ends are matched and the fitting is centered over the leak, damaged area or new joint, if applicable, as accurately as possible. Sometimes it is helpful to loosely assemble the fitting to one side of the leak and then reposition it over the leak.
2. All stud bolts and nuts should be uniformly torqued as indicated in the Plidco Torque Chart. The best results are obtained by maintaining an equal gap between the side bars while tightening the bolts. Higher torque values are provided for the bolts located within the clamping areas of the Plidco Clamp+Sleeve.
3. To complete assembly, the stud bolts should be rechecked at the recommended torque. An increase in torque on one stud bolt can cause a decrease in torque on neighboring stud bolts.
4. The side bars are gapped approximately 1/8" in the sealing area when the Plidco Clamp+Sleeve is fully tightened. The gap between the side bars in the clamping area is typically greater than the sealing area and is dependent on pipe size.

FIELD WELDING

Failure to follow field welding instructions could result in explosion, fire, death, personal injury, property damage or harm to the environment.

PIPELINE SHOULD BE FULL AND UNDER FLOW

Use absolutely dry electrodes which are of equal or greater tensile strength than the pipe. Carefully control the size and shape of the circumferential fillet weld. The weld is required to anchor the joint and give longitudinal stability to the pipeline.

The size of the fillet weld should be at least 1.4 times the wall thickness of the pipe. This assumes a 1.0 joint efficiency. You may need to select a different joint efficiency based on your level of inspection or your company's welding policy. Strive for a concave faced fillet weld with streamlined blending into both members; avoid notches and undercuts.

The smoother and more streamlined the weld, the greater the resistance to fatigue failure. The worst possible shape would be a heavy reinforced convex weld with an undercut. Improper weld shape can lead to rapid fatigue failure which can cause leakage, rupture or explosion with attendant serious consequences.

Welders and weld procedures should be qualified in accordance with API Standard 1104, "Welding of Pipelines and Related Facilities", or RP 1107, "Recommended Pipeline Maintenance Welding Practices", latest edition. API 1104 and 1107 have easy to follow directions for procedure qualification.

We encourage the use of low hydrogen electrodes (E-XX18) because of their high resistance to moisture pick-up and hydrogen cracking. Shielded metal arc welding (SMAW) filler metals listed in API 1104 and 1107 include the cellulose coated electrodes (E-XX10 series) which are often preferred because of the excellent downhill welding characteristics. These are acceptable filler metals, provided they are proven by procedure qualification.

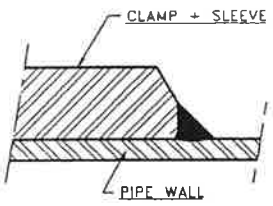
It is very important that the field welding procedure closely follow the essential variables of the qualified procedure so that the quality of the field weld is represented by the physical tests performed on the procedure qualification test specimen.

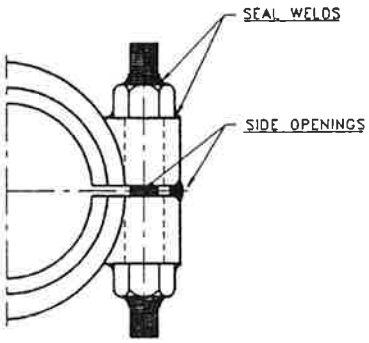
Monitor the heat generated by welding or preheating, particularly near the area of the seals, by using temperature crayons or probe thermometers. If the heat generated approaches the temperature limit of the seal material which is indicated on the label and in the seal lubrication chart, welding should be discontinued or sequenced to another part of the fitting so that the affected area has a chance to cool.

Seal welding the grade B7 stud bolts of the Plidco Clamp+Sleeve is very difficult. The stud bolts are alloy steel with a high carbon equivalence. By using low hydrogen electrodes (E-XX18) and a modest preheat (do not exceed 200°F), the problem of hydrogen cracking and pin holes can be reduced. The preheat will dry out any moisture, oil dampness or thread lubricant that may be present in the seal weld area.

WELDING SEQUENCE

1. Caution should be observed so welding does not overheat the seals. Sequence the welding so the heat is not concentrated in one area. It will be necessary to re-torque the stud bolts periodically during welding because weld contraction causes the stud bolts to loosen.
2. Fillet weld the ends to the pipe.
3. Seal weld the side openings (the gap between the halves).
4. Re-torque the stud bolts.
5. Seal weld the bottoms of the nuts to the side bars.
6. Seal weld the nuts to the stud bolts





FIELD TESTING

The Plidco Clamp+Sleeve is capable of being field testing up to 1½ times its design pressure.

STORAGE INSTRUCTIONS

Plidco Clamp+Sleeve should be stored in a dry environment to prevent any unpainted surfaces from rusting. Storage temperatures should not exceed 120°F (49°C). Cover with dark polyethylene to keep direct sunlight from the seal material. It is best to exclude contamination, light, ozone and radiation. Improper storage can cause the seal material to become cracked and brittle and lose its ability to seal.

PLIDCO TORQUE CHART

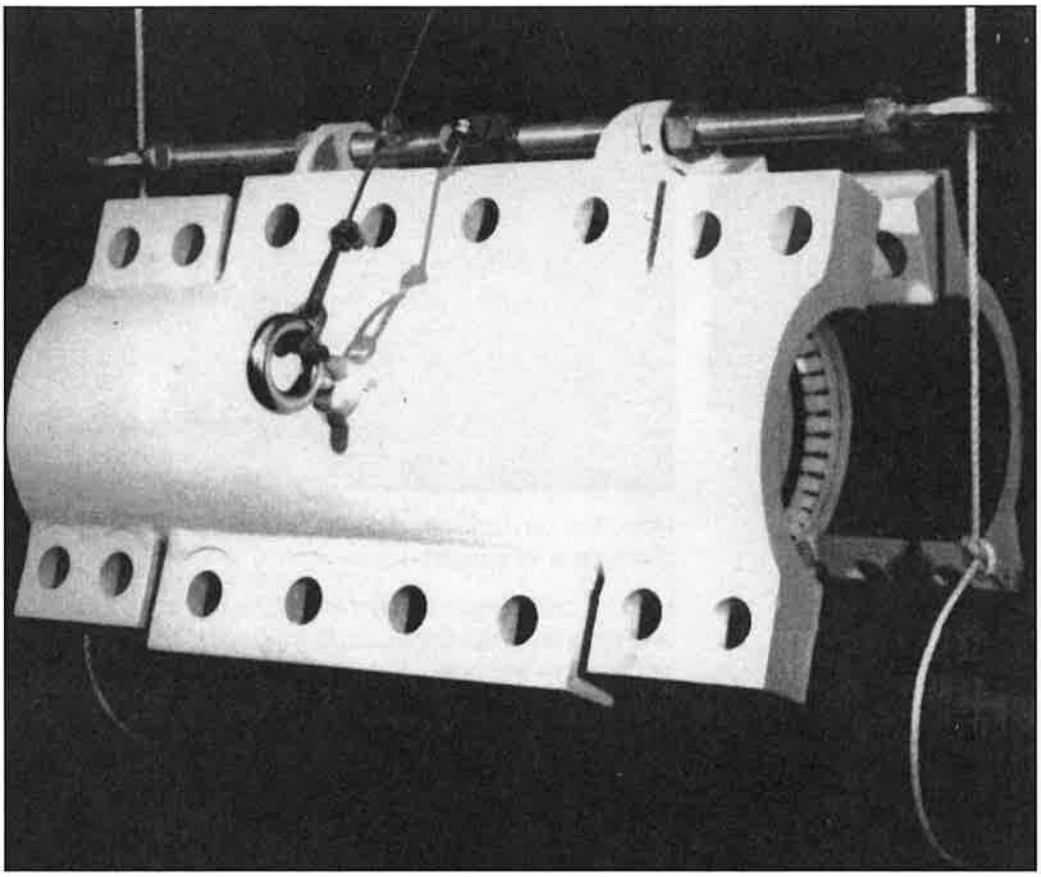
Nominal diameter of studs (inches)	Wrench opening across flats	Torque Values							
		Sealing Area Bolts				Clamping Area Bolts			
		0.08 C_f		0.15 C_f		0.08 C_f		0.15 C_f	
		ft-lbs	Nm	ft-lbs	Nm	ft-lbs	Nm	ft-lbs	Nm
		25,000 psi pre-stress				52,500 psi pre-stress			
5/8--11	1-1/16	33	45	56	76	70	95	118	160
3/4--10	1-1/4	57	77	98	133	120	162	206	280
7/8--9	1-7/16	91	123	156	212	192	259	328	446
1--8	1-5/8	135	183	233	316	284	385	490	664
1-1/8--8	1-13/16	197	267	342	464	414	561	719	975
1-1/4--8	2	274	372	480	651	576	782	1008	1368
1-3/8--8	2-3/16	370	502	651	883	777	1055	1368	1855
1-1/2--8	2-3/8	485	658	857	1162	1019	1382	1800	2441
1-5/8--8	2-9/16	617	837	1096	1486	1296	1758	2302	3121
1-3/4--8	2-3/4	782	1060	1394	1890	1643	2226	2928	3969
1-7/8--8	2-15/16	968	1313	1730	2346	2033	2758	3633	4927
2--8	3-1/8	1180	1600	2116	2869	2478	3360	4444	6025
2-1/4--8	3-1/2	1695	2298	3053	4140	3560	4826	6412	8694
2-1/2--8	3-7/8	2340	3173	4231	5737	4914	6664	8886	12048
		23,000 psi pre-stress				47,500 psi pre-stress			
2-3/4--8	4-1/4	2880	3904	5224	7083	5947	8064	10787	14628
3--8	4-5/8	3785	5133	6885	9336	7816	10598	14218	19280
3-1/4--8	5	4826	6545	8799	11931	9966	13514	18170	24639
3-1/2--8	5-3/8	6043	8194	11037	14967	12478	16921	22794	30908
3-3/4--8	5-3/4	7447	10099	13626	18477	15380	20856	28140	38157
4--8	6-1/8	9055	12278	16590	22497	18699	25355	34262	46460
		18,800 psi pre-stress				37,500 psi pre-stress			
4-1/4--8	6-1/2	8891	12057	16313	22120	17735	24050	32540	44123
4-1/2--8	6-7/8	10569	14331	19413	26324	21082	28586	38723	52508
4-3/4--8	7-1/4	12444	16874	22882	31028	24822	33659	45643	61891
5--8	7-5/8	14530	19703	26743	36263	28983	39302	53344	72334
5-1/4--8	8	16837	22830	31014	42055	33585	45539	61864	83887
5-1/2--8	8-3/8	19375	26272	35717	48433	38647	52405	71245	96609
5-3/4--8	8-3/4	22156	30044	40873	55425	44195	59929	81529	110556
6--8	9-1/8	25191	34160	46504	63059	50249	68139	92761	125783

Studs: ASTM A193 Grade B7 - Nuts: ASTM A194 Grade 2H

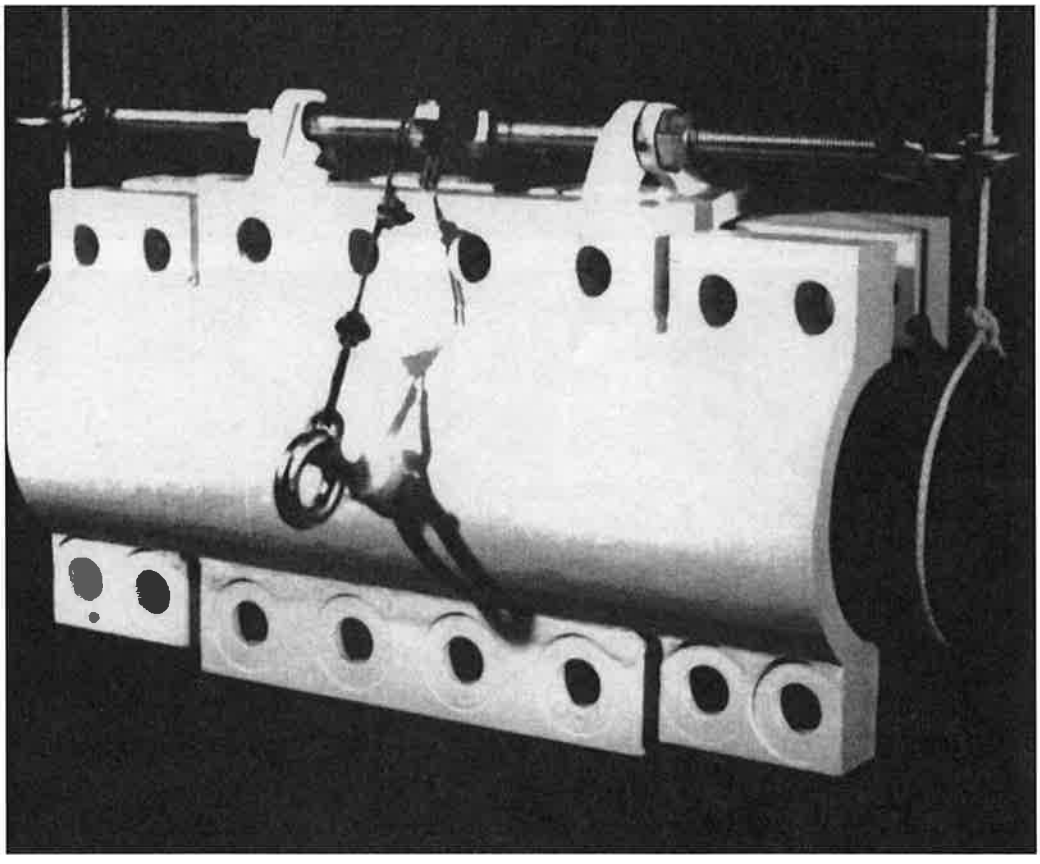
* Torque values shown in the table represent two different coefficients of friction (C_f); 0.08 and 0.15. When C_f equals 0.08, it is assumed the studs and nuts are clean, free running, free of obvious flaws and lubricated with a high grade graphite-oil thread lubricant. When C_f equals 0.15, it is assumed the studs and nuts are clean, free running, free of obvious flaws and lubricated with a light weight machine oil. The torque values are safe minimums and represent approximately the bolt pre-stress values listed in the table.

PLIDCO®

CLAMP+SLEEVE

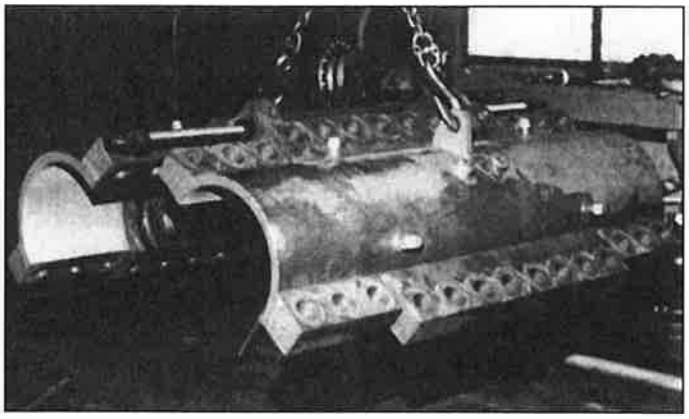


The Plidco Clamp+Sleeve is used for coupling or repairing badly damaged pipe. It has clamping surfaces which grip the outside pipe wall to counteract end-pull and axial stresses often encountered offshore.

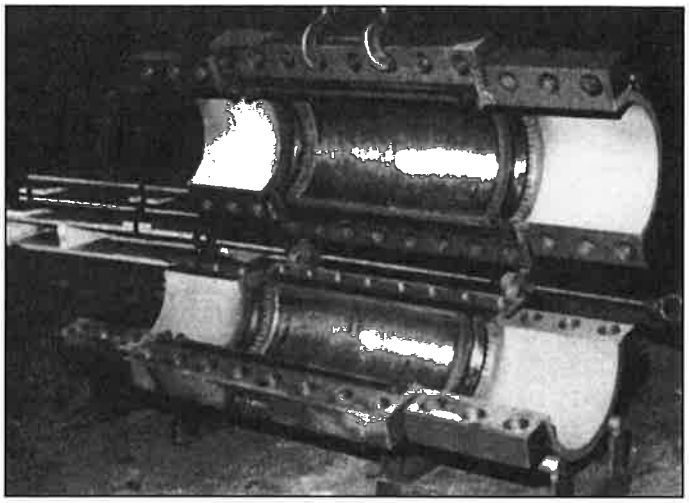


Plidco Clamp+Sleeve with hinges for easier installation.

The hinged sleeve is lowered over the pipe. On contact, the halves close around the pipe, aligning the bolt holes.

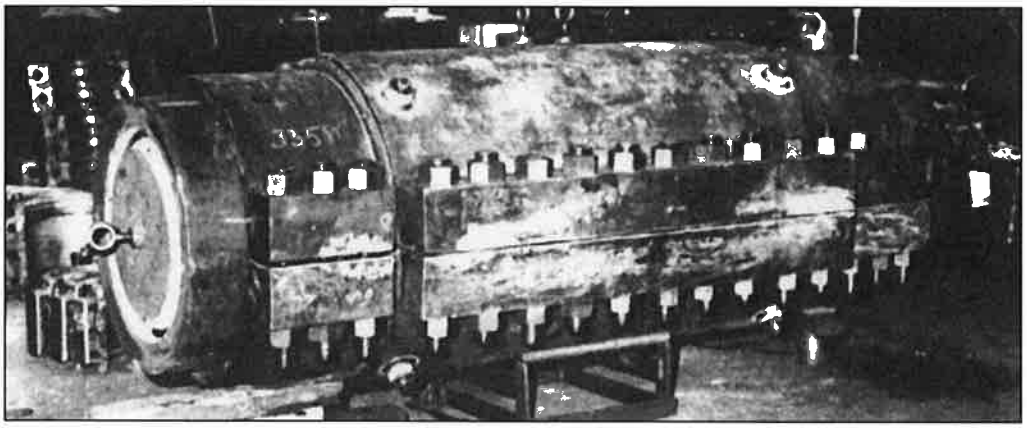


Special Plidco Clamp+Sleeve 10" x 48" long, with a double row of packing.

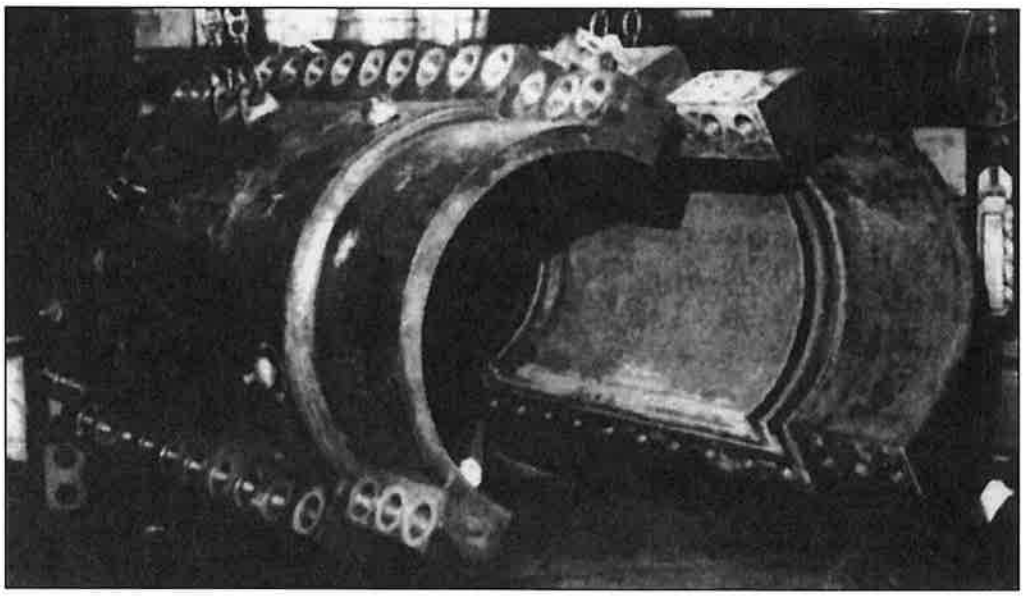


Patented GirderRings hold the packing securely in place during the installation.

Special clamping area surfaces grip the outside wall and provide exceptional holding power without danger of caving in the pipe.



Special 26" x 78" long Plidco Clamp-Oversleeve under test.



Designed with 31" I.D., double row of packing with 42" sealing area, sealant fittings with covers and hinges for easier installation.