

Engineering Procedure

SAEP-312

31 January, 2005

PLIDCO Weld+Ends Couplings

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1 Scope

This SAEP describes the uses, limitations, and installation of PLIDCO Weld+Ends couplings for the purpose of making quick, safe unions on onshore and offshore pipelines, underwater risers, and process piping. Saudi Aramco limits the use of Weld+Ends primarily to pipelines, although they may be used in other areas upon concurrence with the Piping & Valves Unit/M&CED/CSD. Any deviation to this procedure requires the approval of the Manager, Consulting Services Department, Dhahran.

2 Applicable Documents

Saudi Aramco Engineering Procedure

[SAEP-310](#)

Pipeline Repair and Maintenance

Saudi Aramco Engineering Standards

[SAES-A-004](#)

Pressure Testing

SAES-L-010

Limitations on Pipeline Joints

[SAES-W-012](#)

Welding Requirements for Pipelines

Saudi Aramco Standard Drawing

AC-036655

*Tie Rod Arrangement for Weld+Ends PLIDCO
Catalog*

Saudi Aramco General Instruction

GI-0002.100

Work Permit System

3 Instructions

3.1 General

- 3.1.1 PLIDCO Weld+Ends are specialized couplings, used where it is difficult to make quick and safe pipe unions by any other means. They may be used in the repair of onshore or offshore hydrocarbon pipelines, water, steam, or chemical process lines, and underwater risers. PLIDCO Weld+Ends can be welded to the pipe ends or they can be left with clamping and thrust screws tightened, depending on the field situation and product conditions.

- 3.1.2 Proprietary couplings for pipeline repair, such as PLIDCO Weld+Ends shall be of a design approved by the assigned specialist in the Engineering Services Organization. Refer to SAES-L-010, para. 8.5.
 - 3.1.3 Standard PLIDCO Weld+Ends have single rows of clamping screw located on the circumference of each end of the coupling. These couplings are available through the Saudi Aramco Material Supply (SAMS) in sizes 2 through 60 inch. Refer to Table 1 for the coupling's technical specifications and SAMS stock numbers.
 - 3.1.4 Special PLIDCO Weld+Ends have double rows of clamping screws located on the circumference of each end of the coupling. They are designed specially for excessive end pulling loads, and are restricted (color coded white) by Saudi Aramco for submarine pipeline repair only. These couplings are available through SAMS in sizes 8 through 60 inch. Refer to Table 2 for the coupling's technical specifications and SAMS stock numbers.
 - 3.1.5 Other PLIDCO Weld+Ends in special sizes, materials, and pressure designs are available upon request from PLIDCO, including Clamp+Rings. Clamp+Rings are useful in situations where end pulling loads exceed the coupling's "UnWelded Maximum Allowable Operating Pressure (MAOP)" Rating and conditions do not allow for welding on the line, e.g. underwater pipeline repairs. The tremendous gripping strength of the Clamp+Rings prevents all longitudinal movement of the pipe ends. Refer to paragraph 3.2 for the definition of "UnWelded MAOP" Rating.
 - 3.1.6 Packing (Sealant) Material

PLIDCO offers a wide variety of packing (sealant) materials, each having individual pressure, temperature, product compatibility restrictions. To ensure a safe, leak-free seal, it is vitally important that the proper packing material is chosen. As a rule, Saudi Aramco welds all of their Weld+Ends directly to the pipe ends after installation. Therefore, pressure, temperature and product compatibility restrictions become immaterial. Should a Weld+Ends require installation without completely welding it to the line, the Consulting Services Dept. (CSD) shall be notified to approve the packing (sealant) material being used.

 - 3.1.6.1 Currently, the majority of Saudi Aramco stocked Weld+Ends have silicone and Viton packing. Some special Weld+Ends couplings are stocked with Buna-N packing. Viton and Buna-N packing are currently being phased out of stock in favor of the cost effective silicone packing.
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- 3.1.6.2 The manufacturer limits the operating temperature range for:
- i) Silicone packing at -54 to 232°C.
 - ii) Viton packing at -26 to 121°C.
 - iii) Buna-N packing, at -29 to 107°C.
- 3.1.6.3 Silicone packing will harden upon reaction with LPG, or by auto-refrigeration in the case of a leak. Nevertheless, silicone still has the best low temperature properties available and is therefore recommended for LPG service. Welding shall be started within an hour after LPG has entered the line. The coupling shall be completely welded to the line as soon as possible. There shall be no delays between the start and completion of welding.
- 3.1.6.4 Although Silicone packing is recommended when coupling LPG lines because of its low temperature properties, it is not recommended for hydrocarbon service. Silicone readily breaks down in this environment. When Silicone packing is used in hydrocarbon service, the coupling shall be completely welded to the line as soon as possible. There shall be no delay between the start and completion of welding.
- 3.1.6.5 Weld+Ends with packing materials other than peroxide cured "Viton GF" or "Aflas", servicing pipelines with amine corrosion inhibitor, shall be completely welded to the line as soon as possible. There shall be no delays between the start and completion of welding.
- 3.1.6.6 Saudi Aramco studies have shown that PLIDCO supplied Buna-N packing is not suitable for H₂S service. Couplings with Buna-N packing in H₂S service shall be completely welded to the line as soon as possible. There shall be no delays between the start and completion of welding.
- 3.1.6.7 PLIDCO is currently investigating the utilization of Aflas, a Fluoroelastomer like Viton, which has similar temperature and pressure limitations, and approximately the same cost. Aflas was originally designed for down hole, sour service with amine inhibitors. This is an ideal packing material for couplings which cannot be welded, but rely solely on the packing to provide a safe, leak-free seal.

3.1.7 Shelf Life

- 3.1.7.1 Unlike Buna-N, with a maximum shelf life of 2 to 5 years, Viton and silicone packing material have shelf lives of up to twenty (20) years. This can vary with the precautions taken to protect it as specified in paragraph 3.1.6.2.
- 3.1.7.2 The bolts shall be covered with heavy grease to protect them from rusting, and the packing shall be wrapped in plastic wrap to protect them from deteriorating environmental conditions. Along with wrapping in plastic, the following are recommendations to prolong shelf life of the packing:
 - 1) Ambient temperature not to exceed 49°C.
 - 2) Exclusion from air (oxygen).
 - 3) Exclusion from contamination.
 - 4) Exclusion from light (particularly sunlight).
 - 5) Exclusion from ozone generating electrical devices.
 - 6) Exclusion from radiation.

3.2 Maximum Allowable Operating Pressure (MAOP)

As stated in para. 3.1, PLIDCO Weld+Ends can be installed and left in place with clamping and thrust screws tightened, or they can be welded to the pipe ends, depending on the field situation and operating conditions. The method of installing PLIDCO Weld+Ends determines the MAOP of the coupling.

3.2.1 UnWelded MAOP Ratings

After installation and prior to welding the coupling to the pipe ends, it is the strength of the clamping screws and sealant material that provides a secure, leak-free union under prescribed pressure and temperature conditions. This is defined as the "UnWelded MAOP Rating". It is limited to the lesser of:

- 1) The total "Gripping Strength" of the clamping screws, which prevents pipe end movement.
- 2) The "Sealant Strength" of the packing material, which prevents leaks between the coupling and pipe surface interface.

Refer to Table 1 and Table 2 for Unwelded MAOP Ratings of Standard and Specially Designed PLIDCO Weld+Ends.

3.2.1.1 Clamping Screws "Gripping Strength" Pressure Limitations

Longitudinal component forces produced by the internal pressure in the pipeline try to pull the pipe ends apart from the coupling. When tightened properly, the "Gripping Strength" of the coupling's clamping screws prevents this. Refer to para. 3.3.3.

3.2.1.1.1 Standard PLIDCO Weld+Ends have single rows of clamping screw located circumferentially at each end of the coupling. When tightened (torqued) to a recommended minimum torque value, the total "Gripping Strength" of the clamp screws can be calculated using Formula No. 1. This total "Gripping Strength", measured in psi, is enough to prevent the pipe ends from pulling out of the coupling under the same internal pressure value.

Formula No. 1, Used to Calculate the Total "Gripping Strength" of the Clamping Screws on Standard PLIDCO Weld+Ends, is Applicable Only Under the Following Limitations:

- i) Pipe end wall thickness that is equal to or greater than Sch. 40 or ½ inch, whichever is less, and clamp screws that are torqued to PLIDCO's minimum recommended values as shown in Table 4.
- ii) For pipe wall thickness less than Sch. 40 or ½ inch, lower torque values are required to prevent the pipe ends from denting. Lower torque values correspond linearly with lower "Gripping Strength" values. Refer to ATTACHMENT No. 3 for the torque and pressure derating graphs for thin wall pipe, titled "Maximum Allowable Operating Pressure (MAOP) Ratings, Standard PLIDCO Weld+Ends on Thin Wall Pipe".
- iii) At temperatures less than 100 °F, each ⅝ inch clamping screw can resist 3000 pounds of end force, and each ¾ inch clamp screw, 4000 pounds of force.
- iv) For clamp screw temperatures greater than 100°F, refer to Table 3, "Derating of Clamp

Screw Gripping Strength at Temperatures
above 100°F".

For example: A 48 in. coupling has forty two (42) ¾ in. dia. clamping screws. Each clamping screw can withstand 4000 pounds of longitudinal end force when tightened to a prescribed minimum torque value. Using Formula No. 1, the calculated "Gripping Strength" will secure the pipe ends under a maximum internal pressure of 92.84 psig.

Formula No. 1

$$\begin{aligned}\text{Gripping Strength} &= \frac{(N_c \times F_c)}{(3.14 \times R_p^2)} & (1) \\ &= \frac{(42 \times 4000)}{(3.14 \times 24^2)} \\ &= 92.84 \text{ psi}\end{aligned}$$

Where: N_c = Number of clamp screws per end

F_c = Allowable load per screw, lbs.

R_p = Outside radius of the pipe, in.

3.2.1.1.2 Specially Designed PLIDCO Weld+Ends couplings, with double rows of clamping screws at each end, provide added gripping strength and, thus, can operate at a higher MAOP than the standard coupling. The same formula and restrictions for calculating the "Gripping Strength" of standard Weld+Ends is used for specially designed ones, however, PLIDCO only assumes a 75% increase in the MAOP for the second row of clamping screws. Refer to Table 2, "Maximum Allowable Operating Pressure (MAOP) Ratings for Special PLIDCO Weld+Ends with Double Rows of Clamping Screws".

3.2.1.2 Packing Material's "Sealant Strength" Pressure Limitations

3.2.1.2.1 Silicone packing is limited to a "Sealant Strength" of 1000 psig. This limitation is due to silicone's inability to resist extrusion at a pressure higher than 1000 psig.

- 3.2.1.2.2 In all practical purposes, Viton and Buna-N packing have no pressure limitations for "Sealant Strength". Viton and Buna-N can operate at pressures exceeding the "Gripping Strength" of all couplings having either single or double rows of clamping screws. The MAOP ratings of all Weld+Ends couplings, using either Viton or Buna-N packing, is limited to the total "Gripping Strength" of their clamping screws.

3.2.2 Welded MAOP Ratings

The total longitudinal forces resulting from pipe subsidence, thermal expansion and contraction, dynamic loads such as surge or slugged flow, underwater currents, and accidental forces can all act separately or in concert with the axial forces produced by the internal pressure of the line to exceed the UnWelded MAOP, thereby causing the seals to leak or, at worst, separating the pipe ends from the coupling. Welding the pipe ends to the coupling prevents this possibility. When the coupling is properly welded to the pipe ends, the clamping screw's "gripping strength" and the packing material's "sealant strength" become immaterial. It is now the coupling's shell wall thickness and its material strength (SMYS) that determines the coupling's MAOP Rating. This is defined as the "Welded MAOP Rating".

Refer to Table 1 and Table 2 for Welded MAOP Ratings.

Prior to welding, if it is determined that the total longitudinal forces exerted on a coupling will exceed the total "Gripping Strength" of its clamping screws, the ends of the line shall then be anchored using a tie rod arrangement as shown in Saudi Aramco Standard Drawing AC-036655.

3.3 Installation

The Work Permit shall be followed in strict compliance. Refer to GI-0002.100, "Work Permit System". [SAEP-310](#), "Pipeline Repair and Maintenance", shall also be followed in strict compliance when installing PLIDCO Weld+Ends to couple pipelines.

3.3.1 Preparation of Pipe Ends

- 3.3.1.1 Select the location of pipe cuts so that the coupling's clamping screws can grip on a smooth, unpitted surface and the packing material can form a tight even seal. Remove any coatings or

general corrosion around the entire area to be coupled. Longitudinal or spiral weld seams shall be ground flush with the pipe wall and all burrs removed. If the coupling is to be welded after installation, the pipe wall thickness in the vicinity of the fillet girth welds shall be checked by ultrasonic testing (U.T.) to ensure there is a minimum of 5.1 mm (0.20 in.) around the girth weld area. Refer to [SAEP-310](#).

- 3.3.1.2 Check the diameters at both ends of the pipe to be coupled for out-of-roundness and repair if necessary using external line-up clamps or internal jacking. No other special preparation of pipe ends is required, other than as described in paragraph 3.3.1.1. Although, for badly misaligned or out-of-round pipe, it is helpful to grind pilot bevels with generous tapers of approximately 10 degrees from the pipe axis. These bevels eliminate the risk of damage to seals while slipping the coupling over the pipe.

3.3.2 Preparation of Weld+Ends

- 3.3.2.1 Inspect the coupling for evidence of corrosion, fouling, and damaged packing. Be sure all the screws are free to turn and that no sand or any foreign material is in the packing grooves. One practical method of checking the packing is the thumb nail test. Push your thumb nail into the exposed packing. If the packing returns to the original shape, it should be acceptable for use. If the thumb nail imprint stays, the packing shall be replaced.
- 3.3.2.2 Installation of New Packing
- Refer to Attachment No.1 for "Packing Installation Instruction for PLIDCO Weld+Ends".
- 3.3.2.3 Lubricate the prepared pipe surfaces with graphite or a light grease, and slide the coupling completely over one end of the pipe. Mark off one-half of the coupling length from the middle of the gap between the pipe ends, (recommended gap not to exceed $\frac{3}{4}$ inch), to the other end of the pipe surface. Slide the edge of the coupling back to the mark to divide the coupling equally over the joint.

3.3.3 Tightening the Clamping Screws

Do Not Over-Torque The Clamping Screws! Over-torquing may dent the pipe and cause the seals to leak.

- 3.3.3.1 The side clamping screws, (radial set screws), are tightened first. These are the screws with hexagonal heads and cup shaped ends that bear against the pipe. Their function is to resist longitudinal forces, thus preventing the pipe ends from pulling out of the coupling. Refer to Para. 3.2.1.1.
 - 3.3.3.2 Clamp screws come in two sizes, depending on the coupling size. For coupling sizes 1½ through 16 inch, the clamp screw diameter is 5/8 inch. For coupling sizes 18 through 60 inch, the screw diameter is ¾ inch.
 - 3.3.3.3 For pipe wall thickness of Sch. 40 or ½ inch, whichever is less, the clamping screws shall be tightened to the recommended torque values as shown in Table 4.
 - 3.3.3.4 For pipe wall thickness less than Sch. 40 or ½ inch, whichever is less, the clamping screws shall be tightened to the recommended torque values as shown in the torque and pressure derating graphs for thin wall pipe. These lesser clamp screw torque values shall be used to prevent damage to the pipe ends. Refer to Attachment No. 3 for the torque and pressure derating graphs, titled "Maximum Allowable Operating Pressure (MAOP) Ratings, Standard PLIDCO Weld+Ends, on Thin Wall Pipe".
 - 3.3.3.5 In order to obtain a tight fit with equal and accurate clamp screw torque values, the following steps shall be followed:
 - Step 1) Center the Weld+Ends using the clamp screws at the 12, 6, 3, and 9 o'clock positions. These screws are only hand tightened (snug).
 - Step 2) Adjust the gap between the pipe and coupling interface to ensure equal spacing. It is very important to provide a concentric, equal gap between this interface to ensure an optimum packing seal when the thrust screws are tightened. Refer to Section 3.3.4.
 - Step 3) Hand tighten any remaining clamp screws and adjust the gaps as stated in Steps 1 and 2.
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- Step 4) Advancing circumferentially, begin torquing the clamping screws to equal portions of their final recommended torque value. Check the gaps and adjust them to ensure uniformity.
- Step 5) Repeat Step 4 several times until the final recommended torque is achieved. A final torque and gap check of all the clamping screws is recommended. Refer back to paragraphs 3.3.3.3 and 3.3.3.4.

3.3.4 Tightening the Thrust Screws

3.3.4.1 Thrust screws activate the seal packing. These screws are tightened AFTER the clamping screws are torqued. Thrust screws, located at each end of the coupling, advance the packing material and compresses it between the coupling and pipe wall interface to form a seal. When torqued to the recommended minimum torque values, as shown in Table 5, the thrust screws secure a tight seal formed by the packing. The packing will prevent leakage up to it's prescribed maximum operating pressure limitation. Refer to para. 3.1.1.2.

3.3.4.2 Tighten the thrust screws using the following steps:

- Step 1) Tighten all screws until they are snug.
- Step 2) Advance each screw about $\frac{1}{8}$ of a turn before advancing to the next, adjacent screw. Repeat this process as many times as necessary until the recommended torque is reached. Refer to Table 5 for the recommended final torque range of the thrust screws.
- Step 3) Pressurize the line slowly and steadily without surges or slugging, which could vibrate and pull the line ends from the coupling. Do Not exceed the lesser value of the following:
- i) The recommended UnWelded MAOP of the coupling. Refer to Table 1 and Table 2.
 - ii) The maximum design pressure of the line.
 - iii) The maximum calculated pressure as stated in [SAEP-310](#), if the coupling is to be welded to the pipeline.
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Step 4) Tighten the thrust screws as required to stop any leaks that may have developed.

3.3.4.3 The final torquing of the thrust screws should be adequate to prevent any leaking and, thus, complete the Weld+Ends installation. Procedures for welding the coupling to the piping may now begin if required. Refer to Section 3.4.

3.4 Welding

3.4.1 All welding and safety procedures shall conform with [SAEP-310](#), "Pipeline Repair and Maintenance".

3.4.2 All welding of PLIDCO Weld+Ends to piping shall conform to Saudi Aramco Welding Procedure Specification, (WPS) No. PLIDCO-001. Refer to Attachment 2.

3.4.3 The minimum remaining pipe wall thickness at the area to be welded shall be at least 5.1 mm.

3.4.4 The MAOP of the pipeline during welding shall be as stated in para. 3.3.4.2, Step 3. The line shall remain pressurized for at least ½ hour prior to any welding to ensure no leaks form. Tighten the thrust screws as required to stop any leaks that may have developed.

3.4.5 The minimum flow during welding on hydrocarbon pipelines under pressure shall be 0.40 m/s or the maximum attainable under normal working pressure.

The purpose of establishing flow is to ensure that no combustible mixtures can exist on the inside of the pipe while welding on the outside. Sufficient flow must be maintained for a sufficient time to ensure that any potentially explosive gas pockets in the line have been swept clear of the weld area. The flow is not intended to keep the weld area cool, since additional cooling of the weld is undesirable. For any system where combustible mixtures are definitely not a possibility, flow is not necessary. "No-Flow" situations shall be approved by the General Supervisor Operations Engineering and the Operations Superintendent. Operations shall verify a non-combustible mixture in the line and arrangements shall be made to prevent any inadvertent introduction of hydrocarbons or oxygen into the line. This must be stated in the remarks section of the Hot Work Permit.

3.4.6 All welding shall be made with low-hydrogen electrodes. If the pipe wall thickness is less than 0.35 inches, all first layer weld passes onto the

pipe shall be made using 2.4 mm diameter electrodes. Subsequent weld passes may be made with 3.2 or 4 mm diameter electrodes.

- 3.4.7 Weld surfaces, such as the clamping and thrust screws, and the coupling body and adjacent pipe surfaces, shall be free of oil, grease, moisture, rust, scale, paint, metallic coatings, or other foreign matter, prior to welding. Refer to [SAES-W-012](#).
- 3.4.8 Prior to fillet welding the coupling to the pipe ends, a maximum fit-up gap of 3.2 mm between the two surface shall not be exceeded. If the fit-up gap exceeds 3.2 mm, a weld build-up (buttering) shall be made on the pipe at the deficient area to reduce the gap distance. Remove one clamp screw from each top end of the coupling to act as a vent during welding and as a pressure test point after welding.
- 3.4.9 Only the stringer bead weld technique shall be used for all root passes and all subsequent passes if the pipe wall thickness is less than ½ inch. For pipe wall thickness equal to or greater than ½ inch, either the stringer bead or weave technique may be used. The weave width shall not exceed three (3) times the diameter of electrode.
- 3.4.10 Excessive heat, generated during welding, can readily destroy the Weld+Ends packing material. Therefore the temperature adjacent to the packing material shall not be allowed to exceed those values shown in Table 6, "Maximum Allowable Interpass Temperature During Welding of PLIDCO Weld+Ends". The welding interpass temperature shall be continuously monitored with a temperature indicating device, such as a tempilstick or a surface pyrometer. Measurements shall be made adjacent to the clamping screws in the seal packing area.
- 3.4.11 The final girth fillet weld leg size shall be a minimum of 1.5 times the nominal pipe wall thickness.
- 3.4.12 The fillet weld profile shall be as smooth as possible and should be slightly concave. The toe of the fillet weld shall blend smoothly into the pipe wall. It shall be the responsibility the welding inspector to accept the final weld size and profile.
- 3.4.13 The Weld+Ends shall be welded using the following steps:
 - Step 1) Tack weld all of the end thrust screws. Cut them off flush with the coupling face using a grinder with a special cut-off disc. Refer to SAMS S/N 37-708-680. Hold a metal strip between the bolt and pipe to prevent damaging the pipe wall with the grinder. Some projection of the outer edge of the bolt is

acceptable. Keep in mind, the reason for cutting the screws off flush with the coupling face is to prevent lack of fusion and slag entrapment in the fillet girth welds. This has been associated to the cause of leaking couplings in the past.

Step 2) Depending on the position of the coupling, and the proximity of it's ends, both of the Weld+Ends girth welds should be made at the same time. Where possible, use two welders at each end of the coupling to weld on opposite quadrants simultaneously. All passes on the girth fillet weld shall be in the following sequence:

- 1) Weld from 3:00 to 12:00 o'clock position.
- 2) Weld from 6:00 to 9:00 o'clock position.
- 3) Weld from 6:00 to 3:00 o'clock position.
- 4) Weld from 9:00 to 12:00 o'clock position.

Commentary Note:

All of the thrust screw ends shall be welded over.

Step 4) Make a ¼ in. fillet weld, (at least two passes), around all of the clamping screws, except the ones used for venting and leak testing. After welding, either burn off or cold cut the remainder of the clamping screws just above the weld.

Step 5) Apply an air test (5 to 10 psi) at each end of the coupling through the top clamping screw holes. Put soap solution over all the welds and check for leaks. Any areas found leaking shall be ground out, re-welded and air tested as previous. Refer to [SAES-A-004](#), para. 6.18.2.

Step 6) Upon completion of the air test, replace the remaining clamp screws at each end of the coupling. Tighten the clamp screw as described in section 4.3. Weld and cut off the screw ends as described in Step 4.

Revision Summary

31 January 2005

Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with updated list of Committee members.

**Table 1 – Maximum Allowable Operating Pressure (MAOP) Ratings
Standard PLIDCO Weld+Ends with Single Rows of Clamping Screws***

Coupling Size (inches)	Coupling Body Spec.	Unwelded MAOP		Welded MAOP		SAMS Stock No.
		MPa	(psig)	MPa	(psig)	
2	A519 Gr.C 1018-1026	6.89	(1000)	13.79	(2000)	2-161-283
3	A106 Gr.B	6.89	(1000)	13.79	(2000)	2-161-289
4	A106 Gr.B	6.89	(1000)	13.79	(2000)	2-161-293
6	A106 Gr.B	4.80	(696)	13.79	(2000)	2-161-297
8	A106 Gr.B	3.53	(513)	13.79	(2000)	2-161-301
10	A106 Gr.B	2.73	(396)	10.34	(1500)	2-161-306
12	A106 Gr.B	2.26	(328)	8.27	(1200)	2-161-310
14	A106 Gr.B	2.14	(311)	8.27	(1200)	2-161-314
16	A106 Gr.B	1.64	(238)	8.27	(1200)	2-161-317
18	A285 Gr.C	1.73	(251)	8.27	(1200)	2-161-319
20	A285 Gr.C	1.40	(203)	8.27	(1200)	2-161-322
22	A285 Gr.C	1.74	(252)	8.27	(1200)	2-161-329
24	A285 Gr.C	1.46	(212)	8.27	(1200)	2-161-330
26	A285 Gr.C	1.24	(180)	6.89	(1000)	2-161-332
28	A285 Gr.C	1.068	(155)	6.89	(1000)	2-161-333
30	A285 Gr.C	0.931	(135)	6.89	(1000)	2-161-334
31	A285 Gr.C	0.875	(127)	6.89	(1000)	2-161-339
32	A285 Gr.C	1.096	(159)	6.89	(1000)	2-161-343
34	A285 Gr.C	0.965	(140)	6.89	(1000)	2-161-349
36	A285 Gr.C	0.861	(125)	6.89	(1000)	2-161-353
38	A285 Gr.C	0.869	(126)	6.21	(900)	2-161-359
40	A285 Gr.C	0.786	(114)	5.52	(800)	2-161-365
42	A285 Gr.C	0.710	(103)	5.52	(800)	2-161-372
46	A516 Gr.70	0.696	(101)	4.48	(650)	2-161-386
48	A516 Gr.70	0.634	(92)	4.12	(600)	2-161-393
48	A516 Gr.70	0.634	(92)	6.89	(1000)	2-161-396
56	A516 Gr.70	0.655	(95)	5.52	(800)	2-161-405
56	A516 Gr.70	0.723	(105)	6.89	(1000)	2-161-408
60	A516 Gr.70	0.599	(87)	5.52	(800)	2-161-411

Note 1: Sizes 2 through 42 inch use silicone packing. Sizes 46 thru 60 inch use Viton.

Note 2: * Refer to Table 3 for derating of clamp screw Gripping Strength when the pipeline temperature is greater than 100°F. Also, refer to paragraph 3.1 for MAOP restrictions.

**Table 2 – Maximum Allowable Operating Pressure (MAOP) Ratings
Special PLIDCO Weld+Ends with Double Rows of Clamping Screws***

Coupling Size (inches)	Coupling Body Spec.	Unwelded MAOP		Welded MAOP		SAMS Stock No.
		MPa	(psig)	MPa	(psig)	
8	A106 Gr.B	6.19	(898)	13.79	(2000)	2-162-208
8	A106 Gr.B	6.19	(898)	6.89	(1000)	2-161-808
10	A106 Gr.B	4.78	(693)	13.79	(2000)	2-162-212
10	A106 Gr.B	4.78	(693)	6.89	(1000)	2-161-812
12	A516 Gr.70	3.96	(574)	20.68	(3000)	2-162-616
12	A106 Gr.B	3.96	(574)	13.79	(2000)	2-162-216
12	A106 Gr.B	3.96	(574)	6.89	(1000)	2-161-816
14	A516 Gr.70	3.75	(544)	20.68	(3000)	2-162-620
14	A106 Gr.B	3.75	(544)	6.89	(1000)	2-161-820
16	A516 Gr.70	2.87	(416)	20.68	(3000)	2-162-624
16	A516 Gr.70	2.87	(416)	13.79	(2000)	2-162-224
18	A516 Gr.70	3.03	(439)	20.68	(3000)	2-162-628
18	A285 Gr.C	3.03	(439)	6.89	(1000)	2-161-828
20	A516 Gr.70	2.45	(355)	20.68	(3000)	2-162-632
20	A516 Gr.70	2.45	(355)	13.79	(2000)	2-162-232
20	A285 Gr.C	2.45	(355)	6.89	(1000)	2-161-832
22	A516 Gr.70	3.04	(441)	20.68	(3000)	2-162-636
22	A516 Gr.70	3.04	(441)	13.79	(2000)	2-162-236
24	A516 Gr.70	2.56	(371)	20.68	(3000)	2-162-640
24	A516 Gr.70	2.56	(371)	13.79	(2000)	2-162-240
24	A285 Gr.C	2.56	(371)	6.89	(1000)	2-161-840
30	A285 Gr.C	1.63	(236)	6.89	(1000)	2-162-800
Buna-N Packing	or A515 Gr.55 or A516 Gr.55	1.63	(236)	6.89	(1000)	2-162-800
	30 A516 Gr.70	1.63	(236)	13.79	(2000)	2-162-252
	30 A285 Gr.C	1.63	(236)	6.89	(1000)	2-161-852
	31 A285 Gr.C	1.53	(222)	6.89	(1000)	2-162-804
Buna-N Packing	or A515 Gr.55 or A516 Gr.55 A285 Gr.C	1.92	(278)	6.89	(1000)	2-161-856
	36 A516 Gr.70	1.51	(219)	13.79	(2000)	2-162-264
	40 A285 Gr.C	1.38	(200)	6.89	(1000)	2-162-872
	42 A285 Gr.C	1.24	(180)	6.89	(1000)	2-161-876
	48 A516 Gr.70	1.11	(161)	6.89	(1000)	2-161-888
	56 A516 Gr.70			6.89	(1000)	2-161-904
	60 A516 Gr.70			6.89	(1000)	2-162-060

Note 1: All couplings are color coded white and restricted to submarine pipe repair.

Note 2: All coupling supplied with Viton packing unless otherwise note.

Note 3: * Refer to Table 3 for derating of clamp screw Gripping Strength when the pipeline temperature is greater than 100°F. Also refer to paragraph 3.1 for MAOP restrictions.

**Table 3 – Derating of Clamp Screw Gripping Strength
at Temperatures Above 100°F**

Pipe Temperature (°F)	Percentage of Calculated Gripping Strength
100	100
200	90
300	80
400	70

Direct interpolation between temperature increments is permissible.
(Example: 243°F = 85.7% of the calculated Gripping Strength)

**Table 4 – Minimum Torque Values
PLIDCO Weld+Ends Clamp Screws on Pipe Wall Thickness
Equal to or Greater Than Sch. 40 or ½ inch, Whichever is Less**

Screw Size	Minimum Recommended Torque	
	Foot-lbs.	Newton-meter
5/8 in.	100	136
¾ in.	150	204

NOTE: For pipe with a wall thickness less than schedule 40 or ½ inch, whichever is less, refer to Attachment No. 3 for the torque and pressure derating graphs for thin wall pipe titled " Maximum Allowable Operating Pressure (MAOP) Ratings, Standard PLIDCO Weld+Ends on Thin Wall Pipe".

Table 5 – Minimum Torque Range PLIDCO Weld+Ends Thrust Screws

Screw Size	Minimum Recommended Torque	
	Foot-lbs.	Newton-meter
3/8 in.	20-25	28-34
1/2 in.	30-40	41-55
5/8 in.	70-80	95-109

**Table 6 – Maximum Allowable Interpass Temperature
During Welding of PLIDCO Weld+Ends**

Type of Packing	Interpass Temperature
Viton	232°C
Silicone	232°C
Buna-N	121°C

Attachment 1 – Packing Installation Instruction for PLIDCO Weld+Ends

1. Remove all thrust and clamp screws.
2. Remove old packing and keep thrust ring to outside end of fitting (insert screwdriver under packing, lift, then pull from the packing groove).
3. Insert new packing. Flat side of packing must face thrust ring and radius side of packing must face the radius corner of the packing groove. If strip is furnished instead of a molded ring, glue the ends during installation being careful not to bond the packing to the filling.
4. Figure 1 is the recommended method of packing ring installation. The loops are easily pressed into the groove with the heel of the hand.
5. Insert thrust and clamp screws.
6. Follow PLIDCO Weld+Ends instructions.

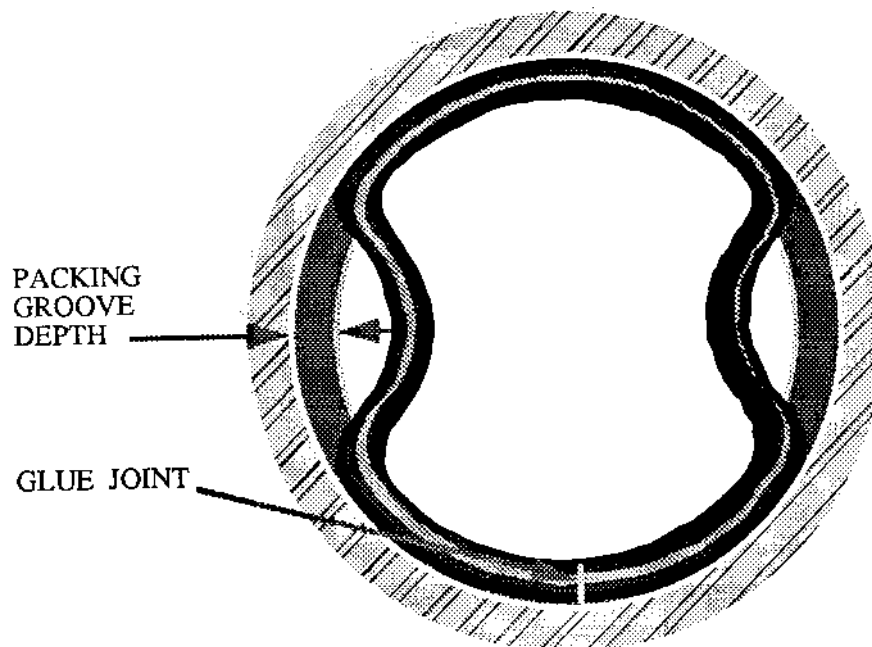
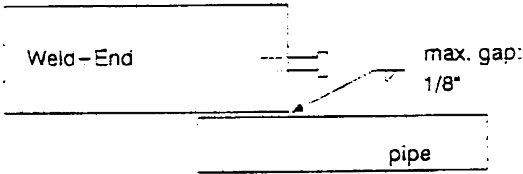


Figure 1

Attachment 2 – Welding Procedure Specification

WELDING PROCEDURE SPECIFICATION

Company Name <u>Saudi Aramco</u>		Welding Procedure Specification No. <u>PLIDCO-001</u>	
by: <u>Thomas Doody</u>		Revision <u>1</u>	Date <u>MARCH 1, 1993</u>
Welding Process(es) <u>SMAW</u>	Supporting <u>3</u>	Code: ☒ ASME IX ☐ AWS D1.1 ☐ API 1104 ☐ Other	
BASE METALS for pipeline repair sleeves, patches, and weld build-up			
P-No. <u>1</u>	Group No. <u>1, 2</u>	to P-No. <u>1</u>	Group No. <u>1, 2</u>
Specification <u>API Gr. B, X42, X52, X60</u> (type and grade) or A516		Specification _____ (type and grade)	
Base Metal Thickness Range: Groove <u>0.200"</u> min. to <u>1.5"</u> max.		0.200" minimum Fillet to unlimited	
Pipe Diameter Range: <u>2" NB</u> min. to <u>unlimited</u> max.			
JOINTS FOR WELD+ENDS ONLY		Sketch Details:	
Joint Design <u>fillet</u>			
Backing: No <u>X</u> Yes _____ (list material and type)			
FILLER METALS		Notes:	
AWS Class. <u>E7018</u>		1) If the gap between the Weld+End and pipe exceeds 1/8 inch, the pipe wall must be buttered until the specified gap is achieved.	
Spec No. <u>A5.1</u>		2) After installation, the thrust screws are to be tack welded and cut off flush with the Weld+End face.	
F-No. <u>4</u>		3) The final fillet weld leg size shall be 1.5 times the pipe wall thickness.	
A-No. <u>1</u>			
Size(s) <u>3/32, 1/8, 5/32"</u>			
Max. Deposit Thickness Groove <u>1.5"</u>			
Trade Name _____			
Other _____			
SAUDI ARAMCO TECHNICAL APPROVAL		For Contract/Job <u>Weld+End pipeline repair</u>	
Name <u>Thomas Doody</u>		Unit/Dept. <u>CSD/CCD/MEU</u>	
Signature <u>Thomas Doody</u> 3/1		Date <u>March 1, 1993</u>	
☒ Approved without comment		☐ Approved with comments	
☐ Approved with restrictions: _____			

Attachment 2 (Continued)

WELDING PROCEDURE SPECIFICATION

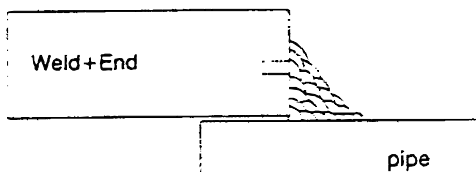
Page 2

Company Name <u>Saudi Aramco</u>		Welding Procedure Specification No. <u>PLIDCO-001</u>	
POSITIONS Groove position <u>All</u> Welding progression <u>V-up</u> Fillet position <u>All</u>		PREHEAT Preheat temp. <u>70 F</u> Wall Thickness <u>< 1.5"</u>	* - 450 F for viton or silicon packing Interpass Temp. (max.) <u>250 F</u> Preheat Maintenance _____ Other _____
SHIELDING GAS Shielding Gas <u>N/A</u> Backing <u>N/A</u> Other <u>N/A</u>		Composition _____ Flow Rate _____	POST WELD HEAT TREATMENT Soak Temperature <u>N/A</u> Soak Time _____ Heating Rate _____ Cooling Rate _____ Other _____

JOINT DESIGN AND DEPOSITION SEQUENCE

Sketch Details:

- 1) All first layer passes onto pipe wall shall use 3/32" dia. if WT < 0.35".
- 2) Stringer beads must be used if pipe WT < 0.5".
- 3) Welding shall be sequenced in opposite quadrants.



Layer	Process	Class	Dia.	Polarity	Amperage Range	Voltage Range	Travel Speed	Wire Feed Speed	Other
end fillet:	SMAW	E7018	3/32	DCRP	75-100	22-24	4-6	N/A	stringer
root			or 1/8	•	100-120	22-24	2-4		
fill and cap	•	•	1/8	•	100-120	22-24	2-4		
	•	•	or 5/32	•	140-180	24-28	2-6		

String or weave Bead string and weave (only up to 3 x electrode dia. and only if WT > 0.5")

Mode of metal transfer for GMAW and FCAW N/A

Multiple or Single Pass (per side) multiple

Multiple or single electrodes single

Initial and Interpass Cleaning brushing and/or grinding

Method of Backgouging N/A

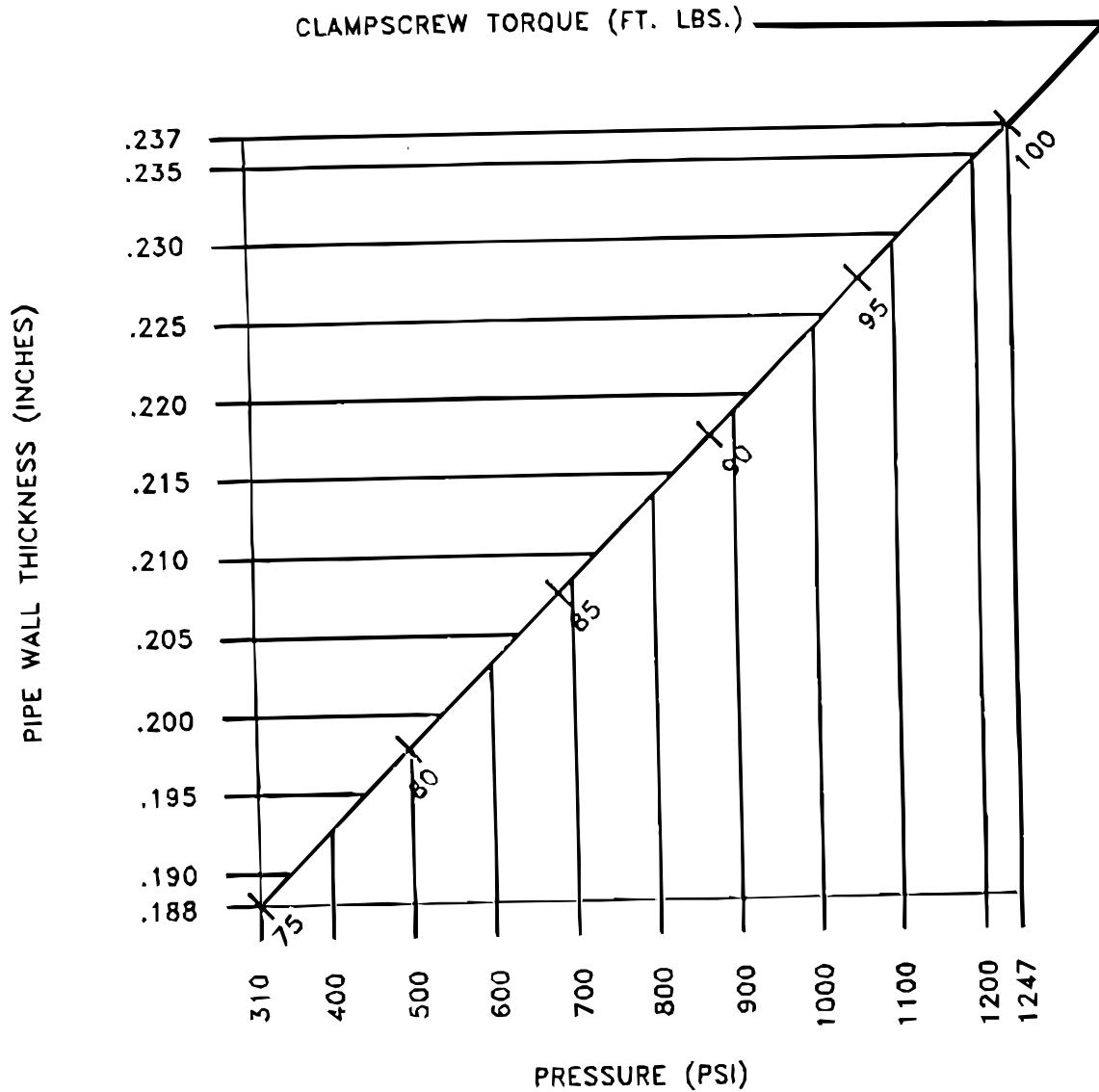
Oscillation N/A Contact tube to Work Distance N/A

Orifice or Gas Cup Size N/A Tungsten Electrode Size and Type N/A

Peening not permitted

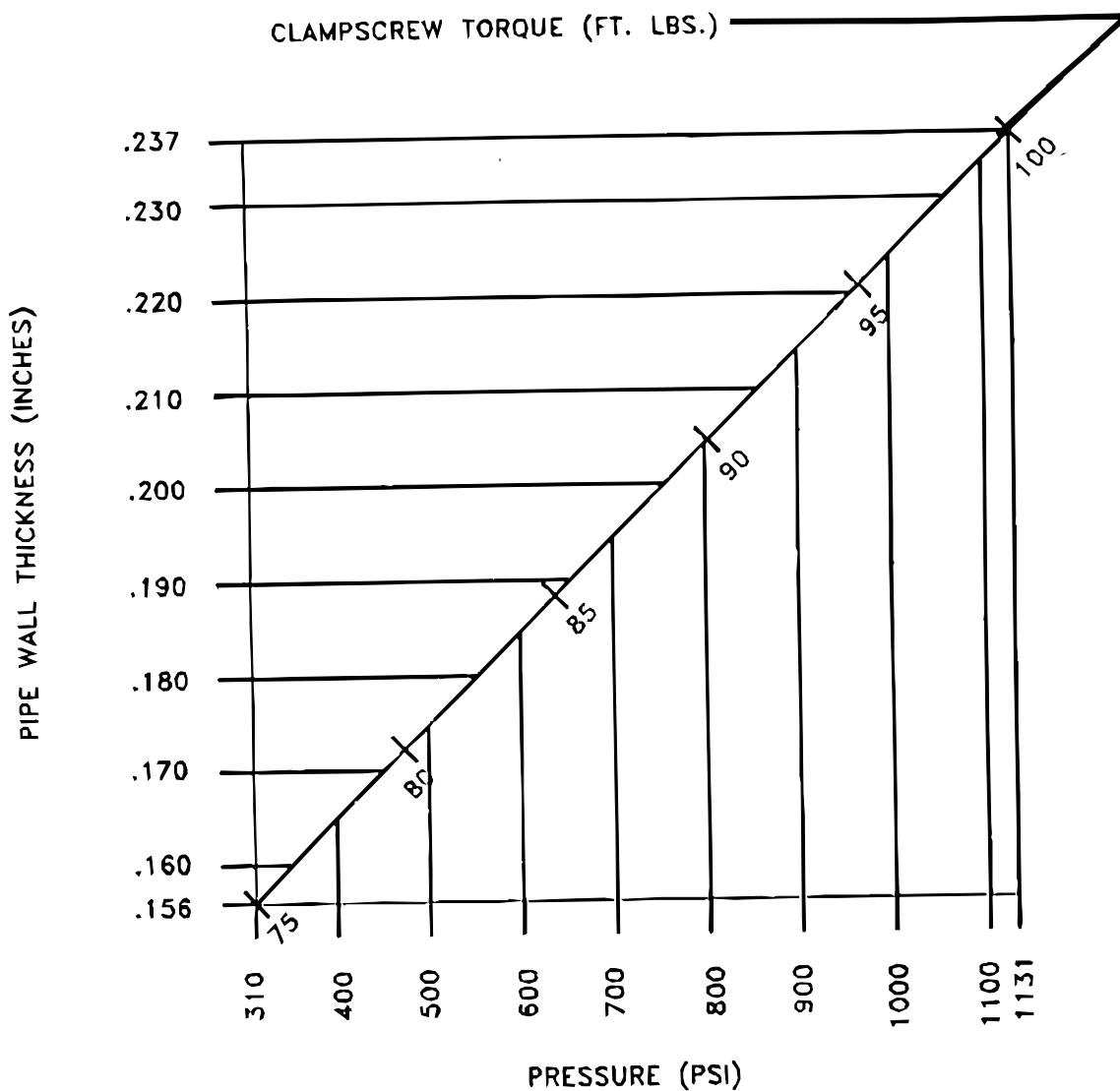
Attachment 3

Maximum Allowable Operating Pressure (MAOP) Ratings 3" Standard PLIDCO Weld+Ends on Thin Wall Pipe



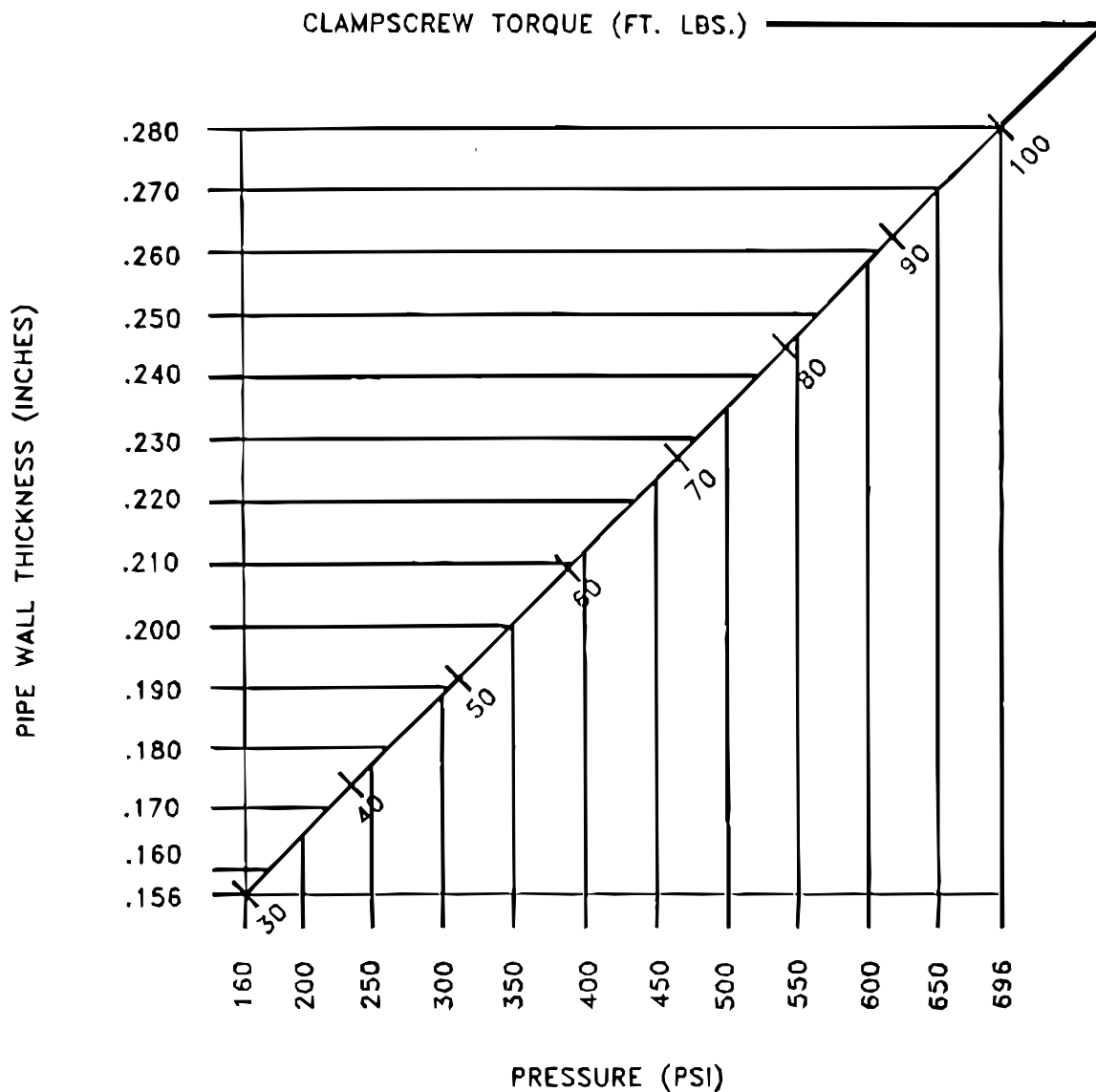
Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (MAOP) Ratings
4" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



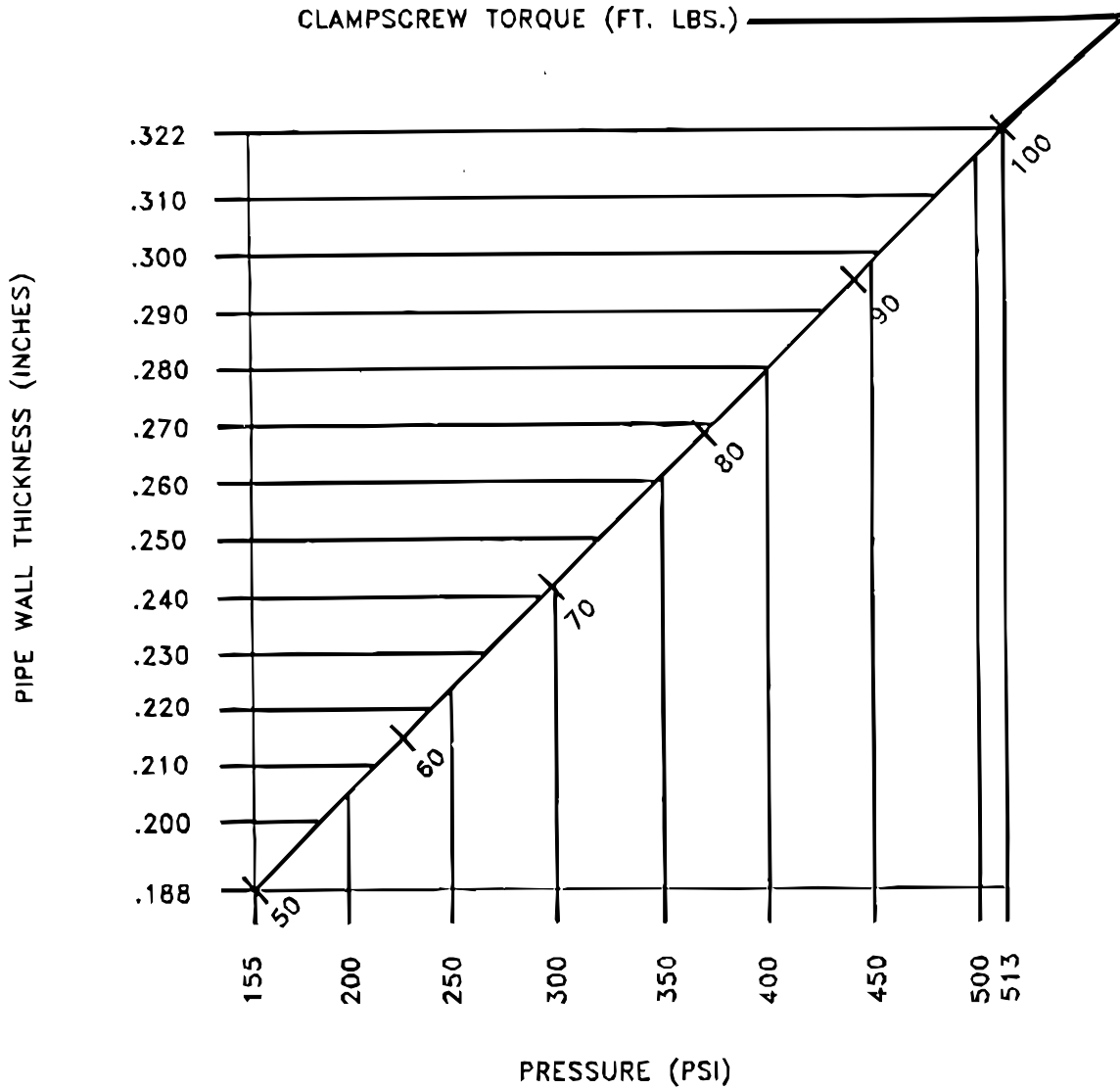
Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (MAOP) Ratings
6" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



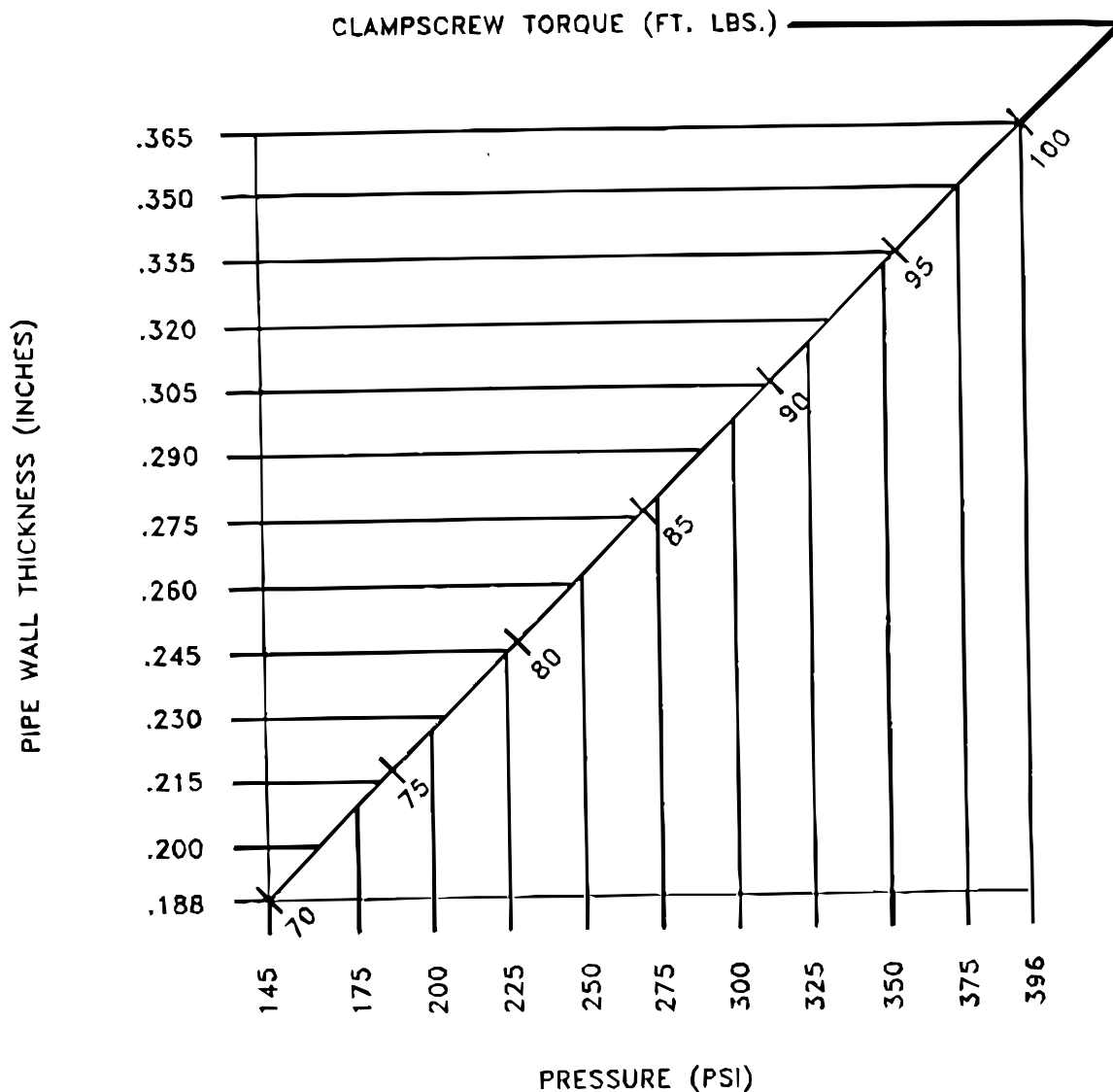
Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (MAOP) Ratings
8" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



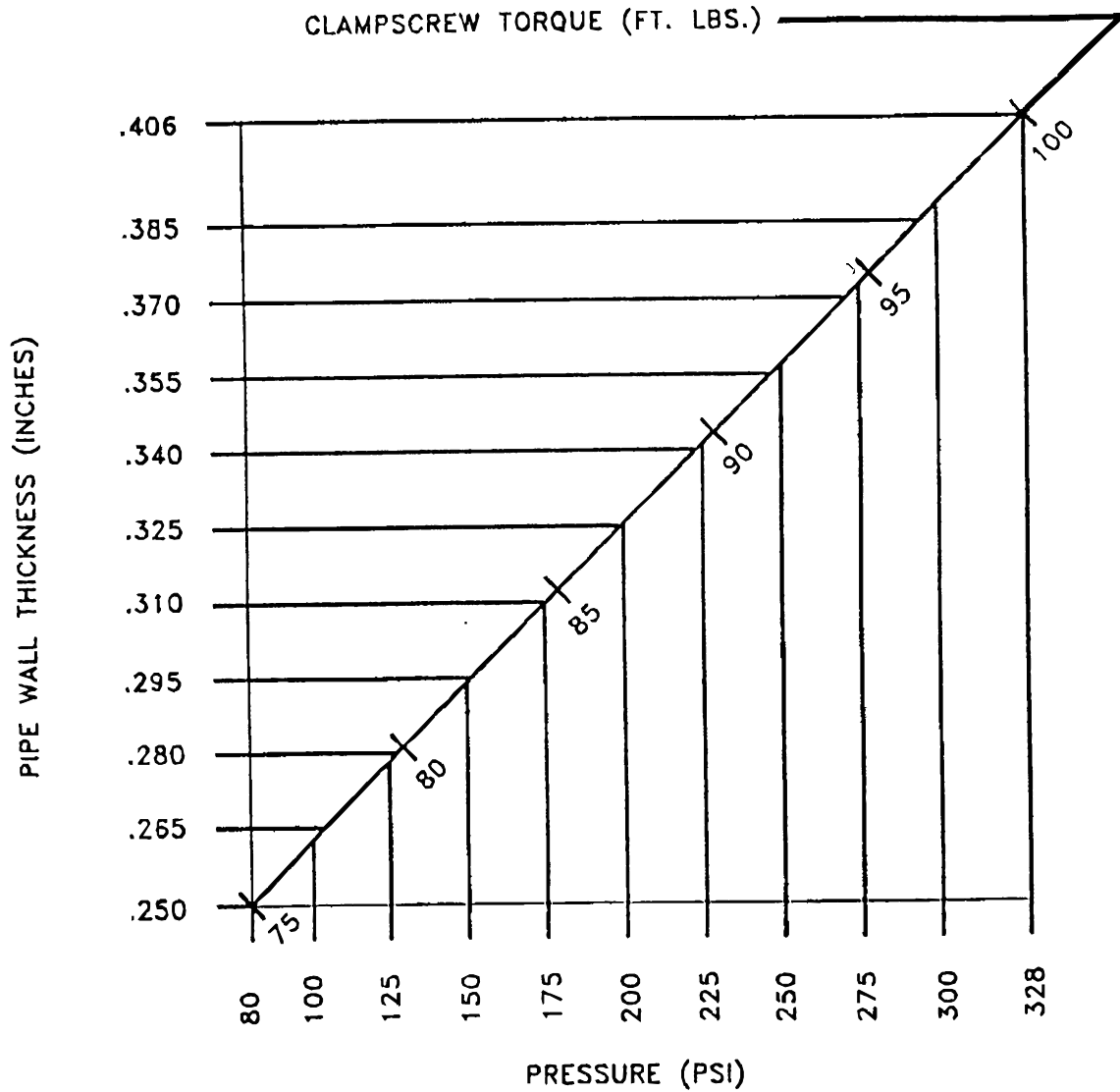
Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (MAOP) Ratings
10" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



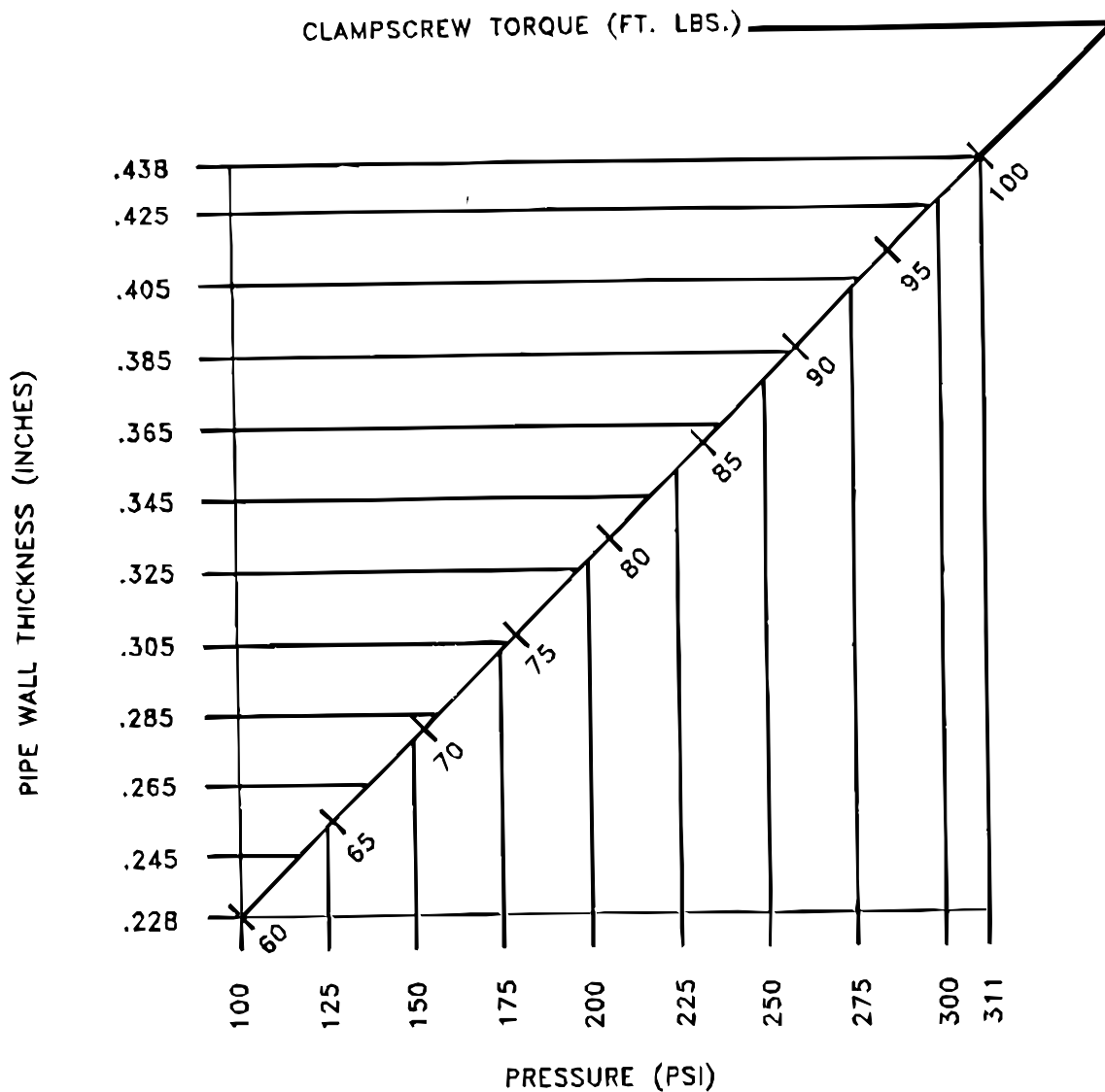
Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (MAOP) Ratings
12" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



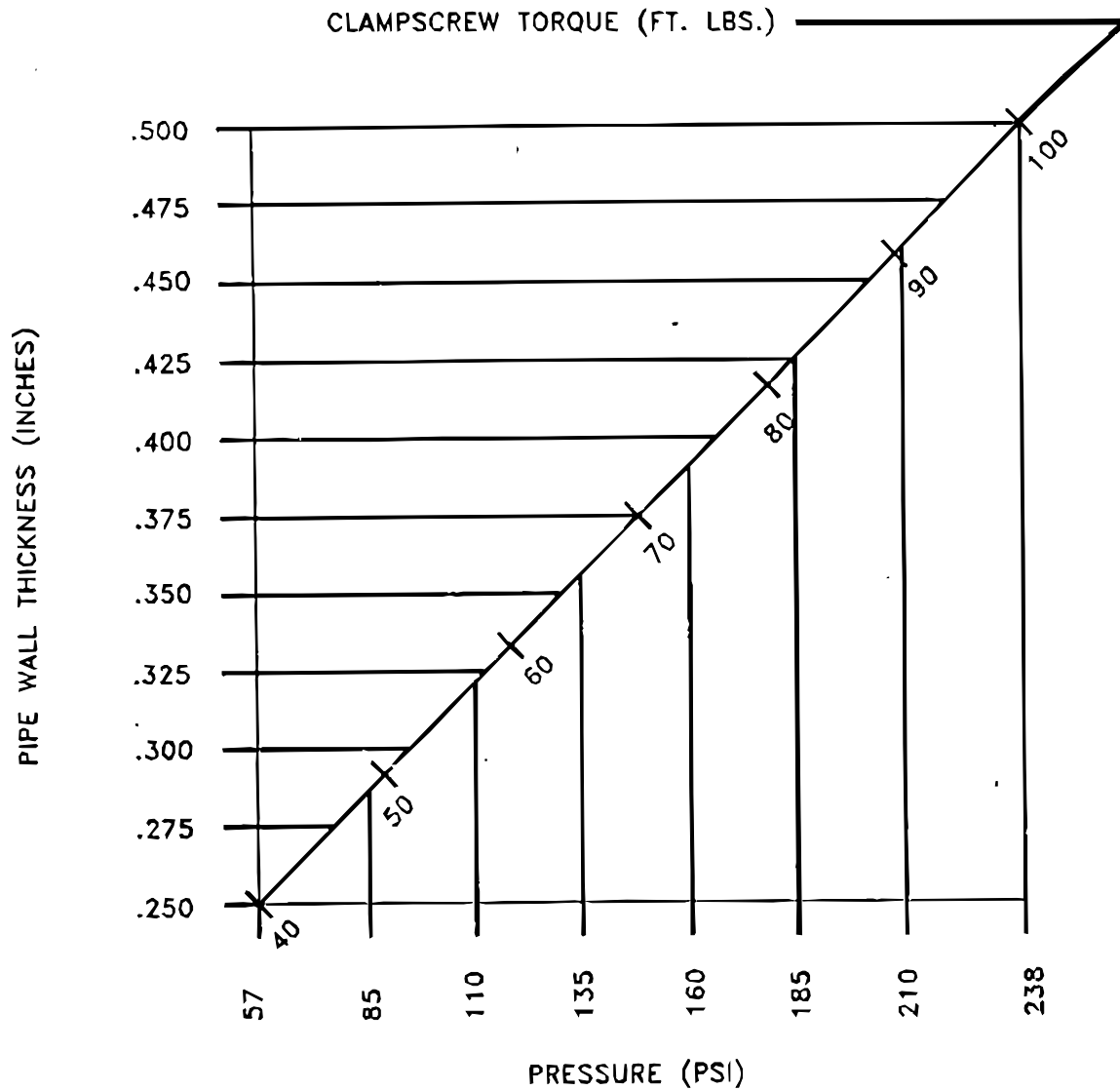
Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (MAOP) Ratings
14" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



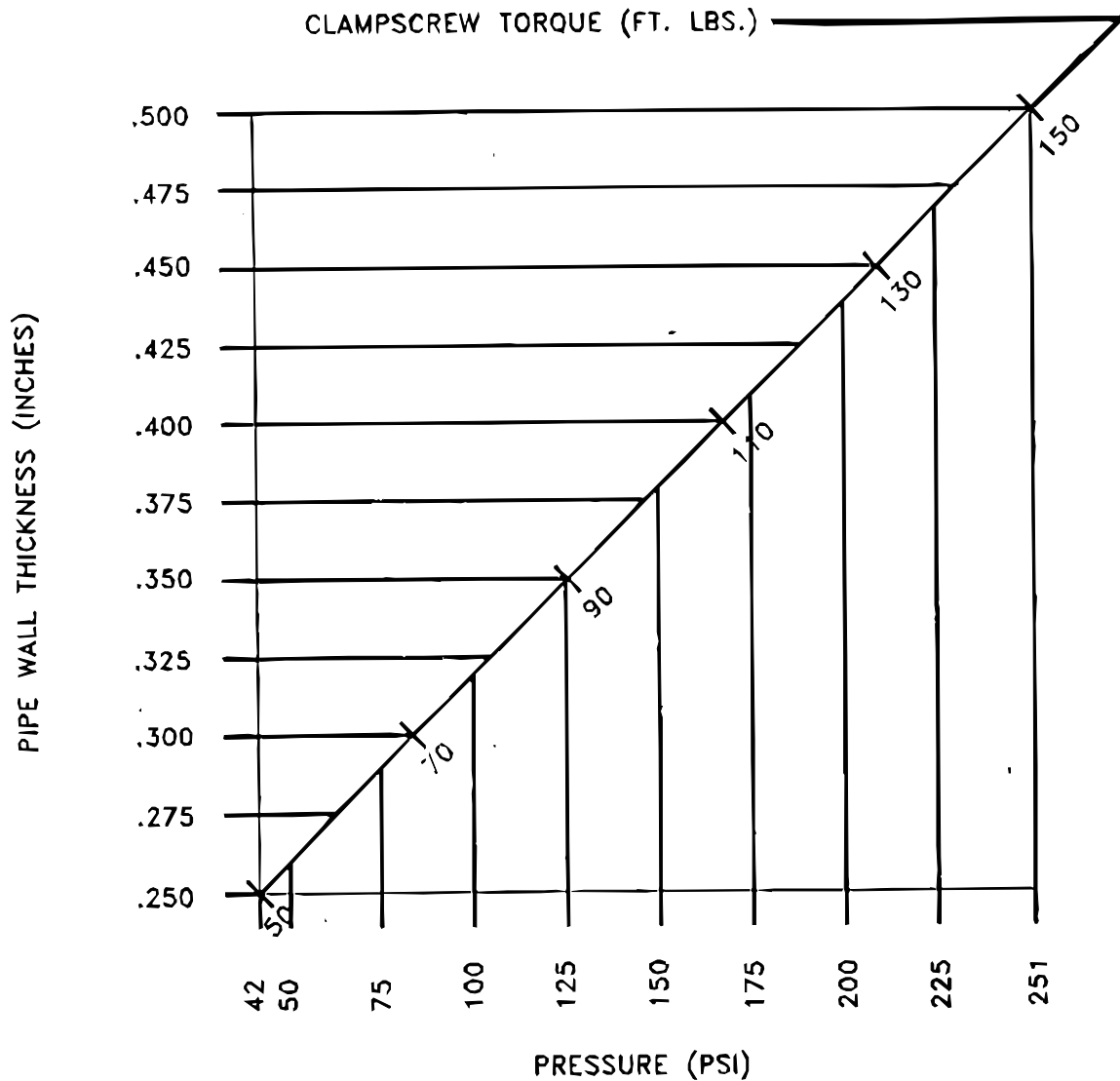
Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (MAOP) Ratings
16" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



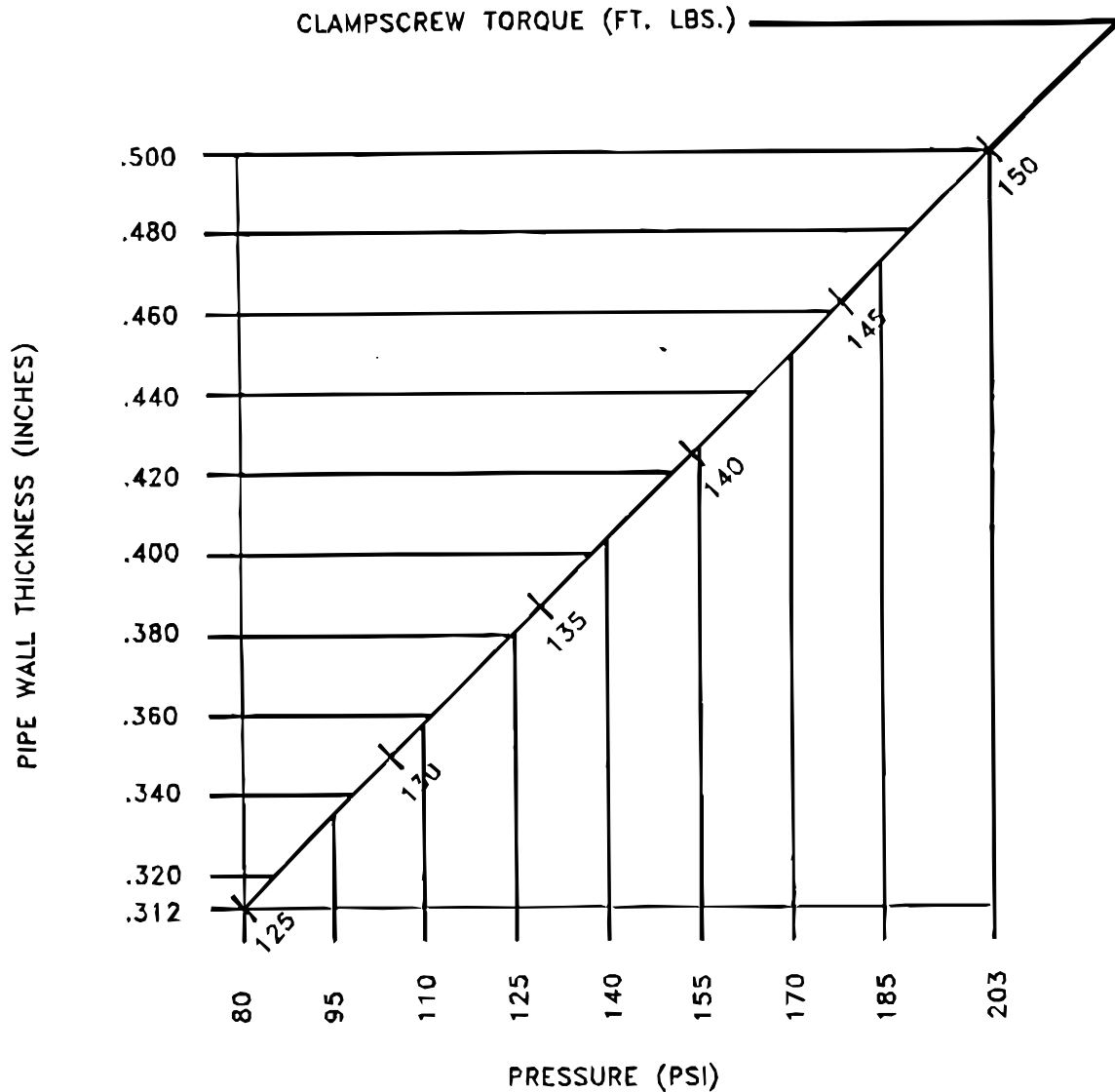
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**Maximum Allowable Operating Pressure (MAOP) Ratings
18" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



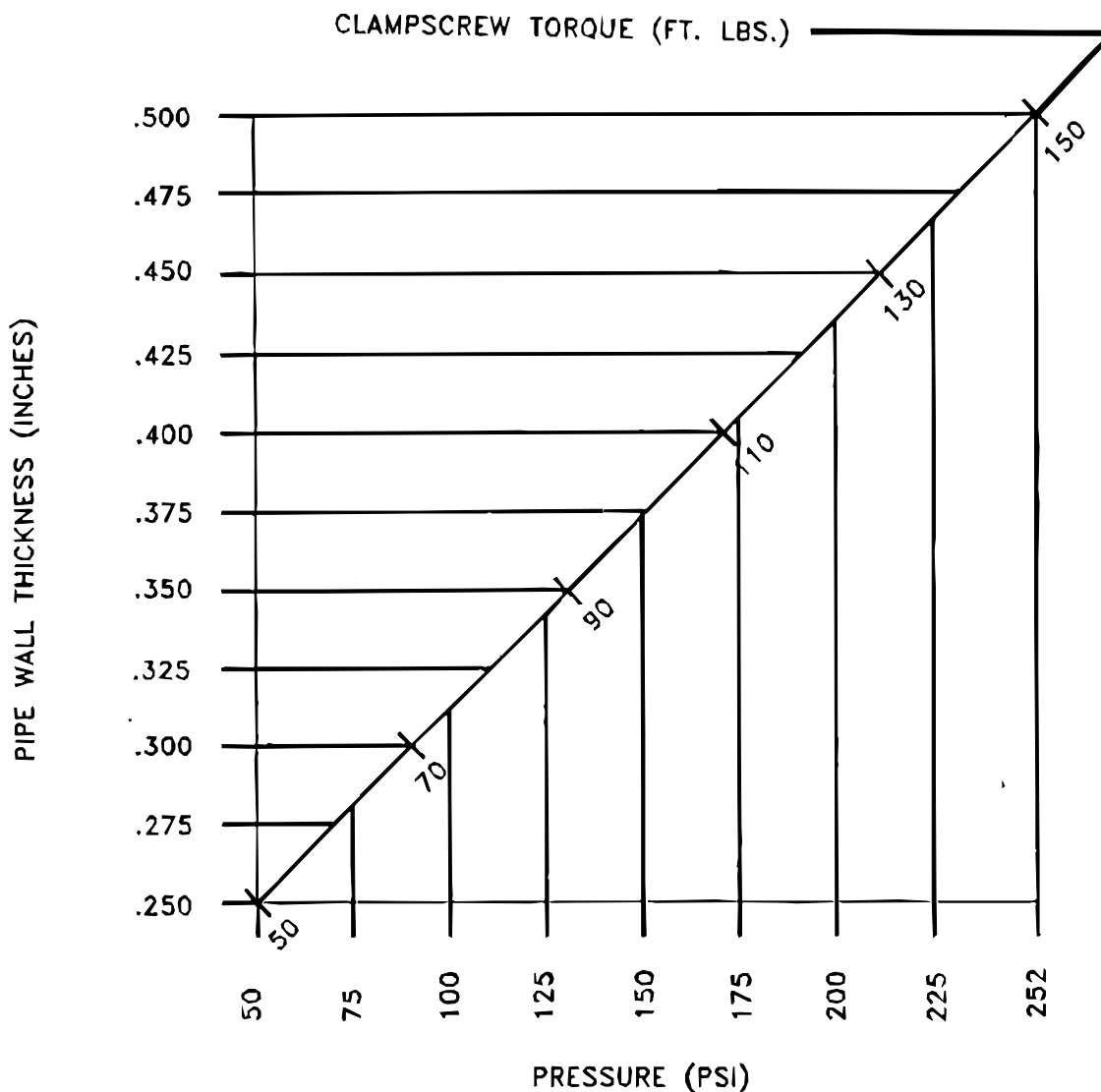
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**Maximum Allowable Operating Pressure (MAOP) Ratings
20" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



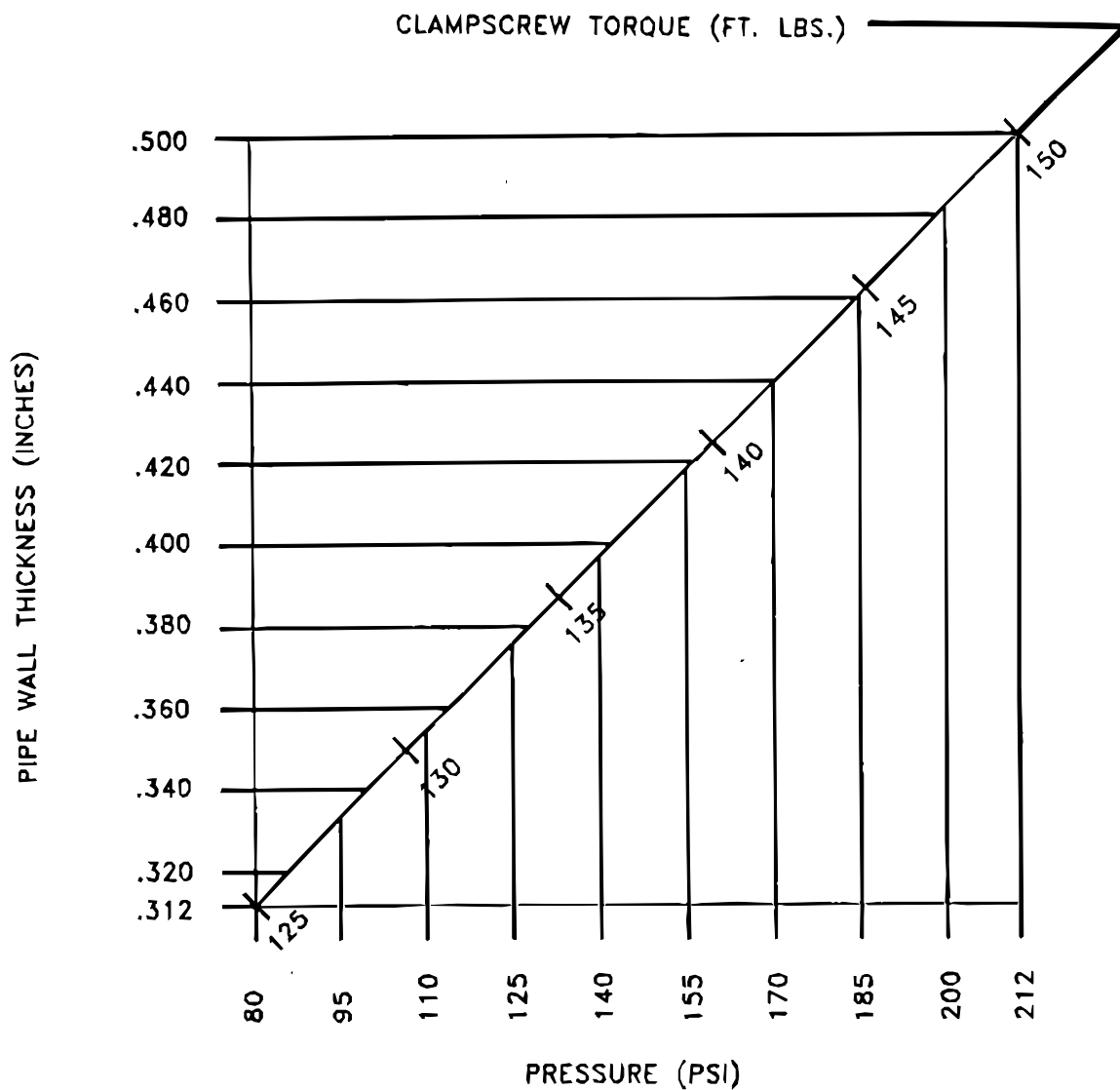
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**Maximum Allowable Operating Pressure (MAOP) Ratings
22" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



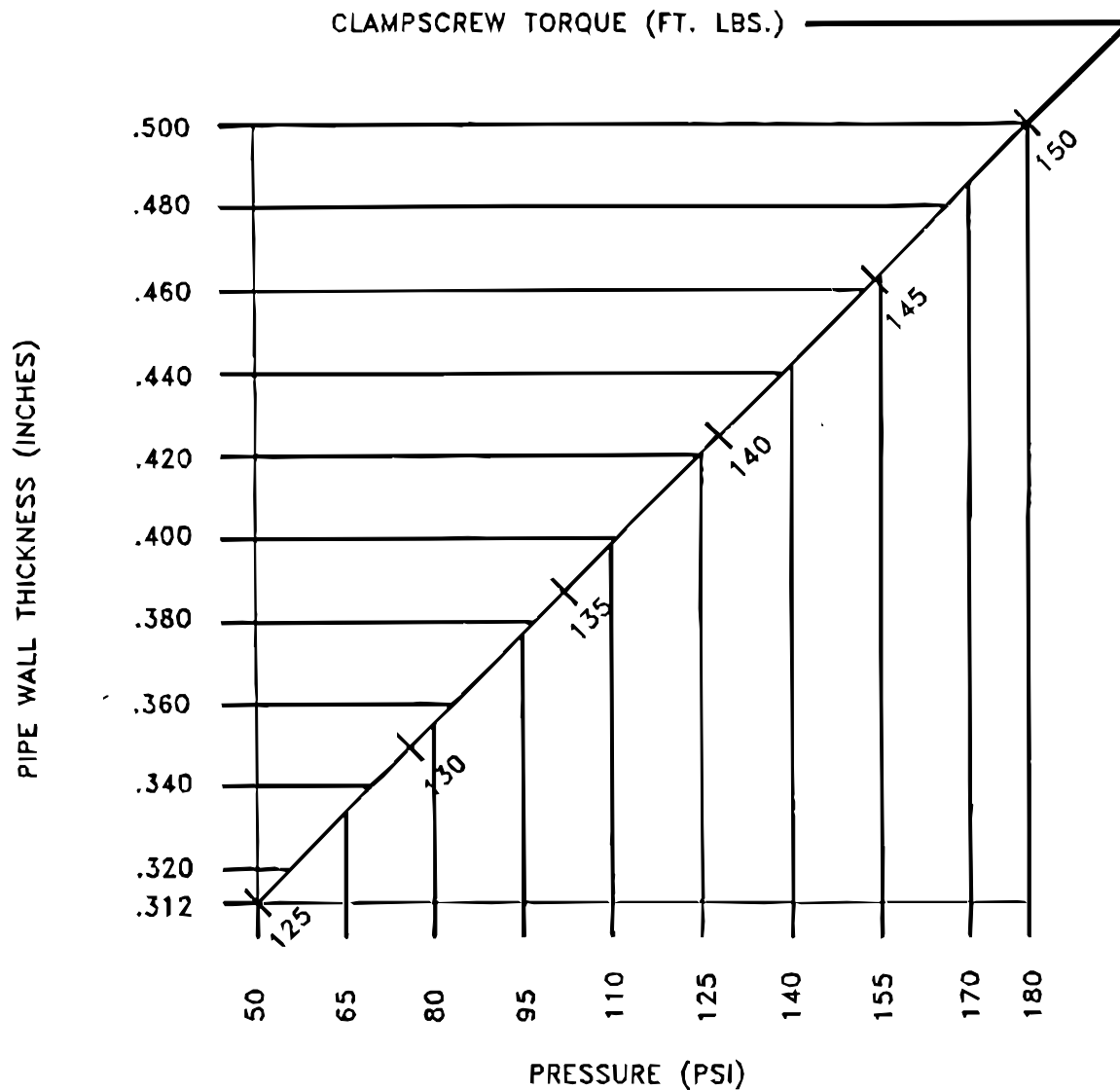
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**Maximum Allowable Operating Pressure (MAOP) Ratings
24" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



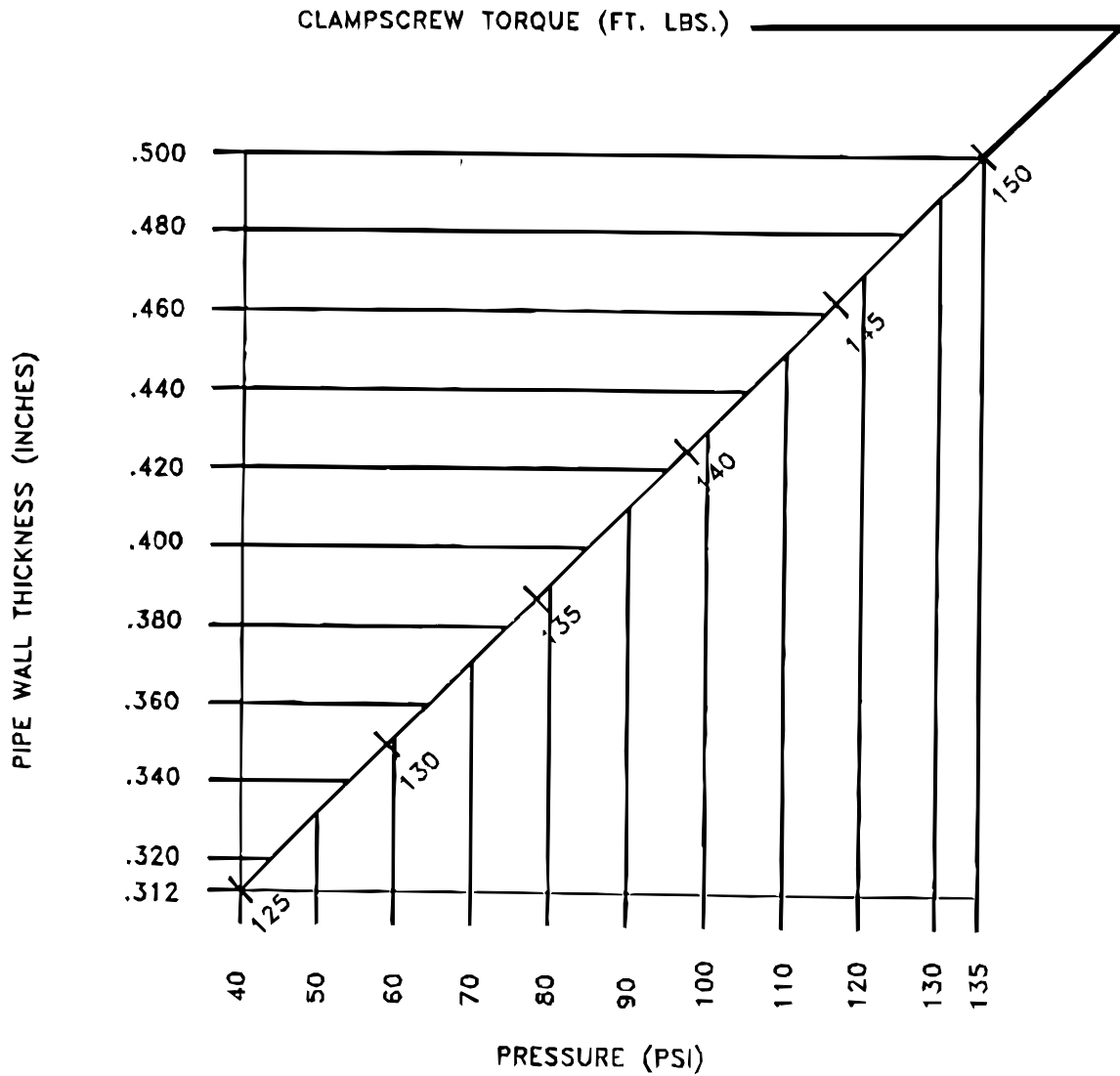
Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (MAOP) Ratings
26" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



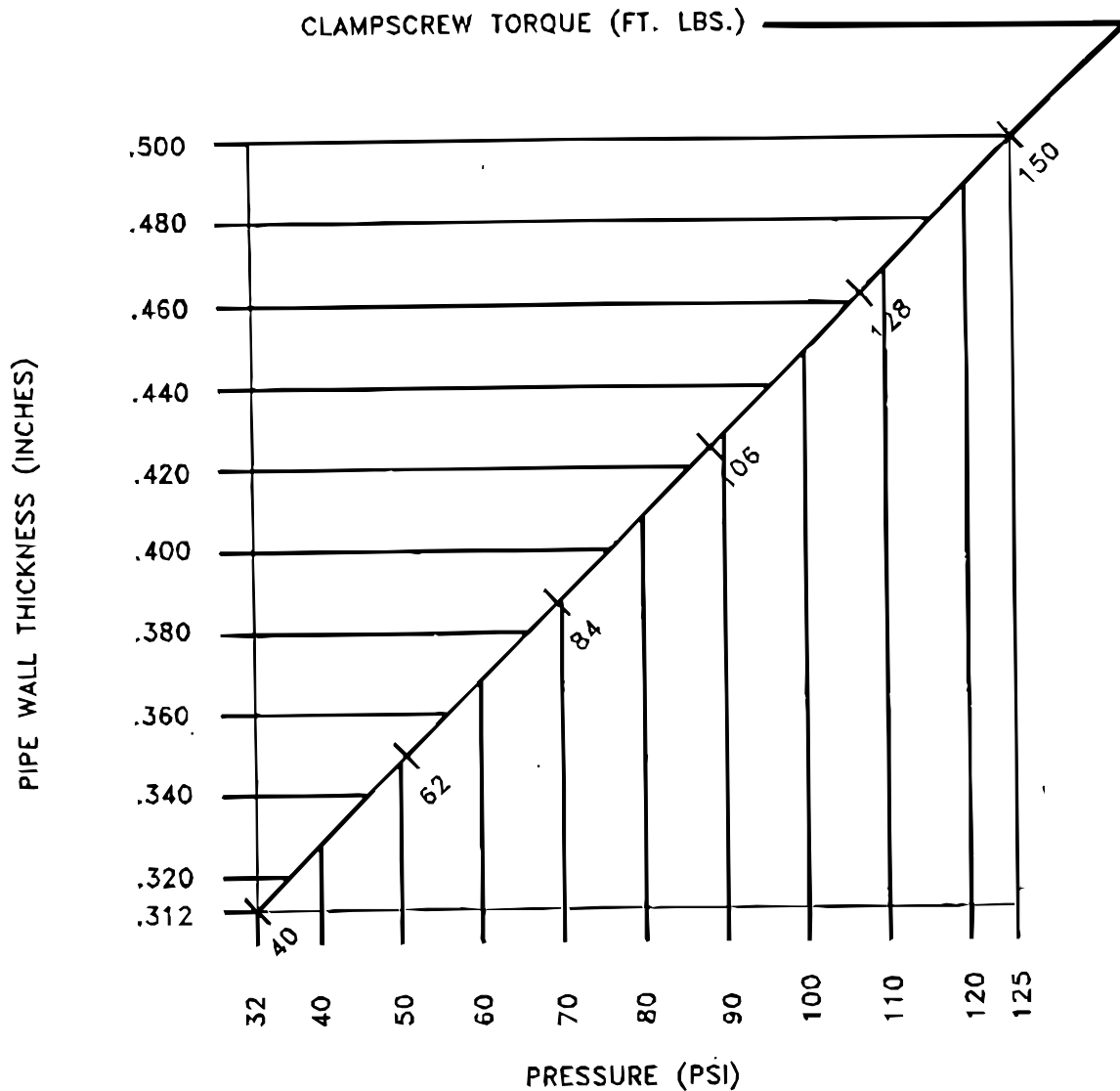
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**Maximum Allowable Operating Pressure (MAOP) Ratings
30" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



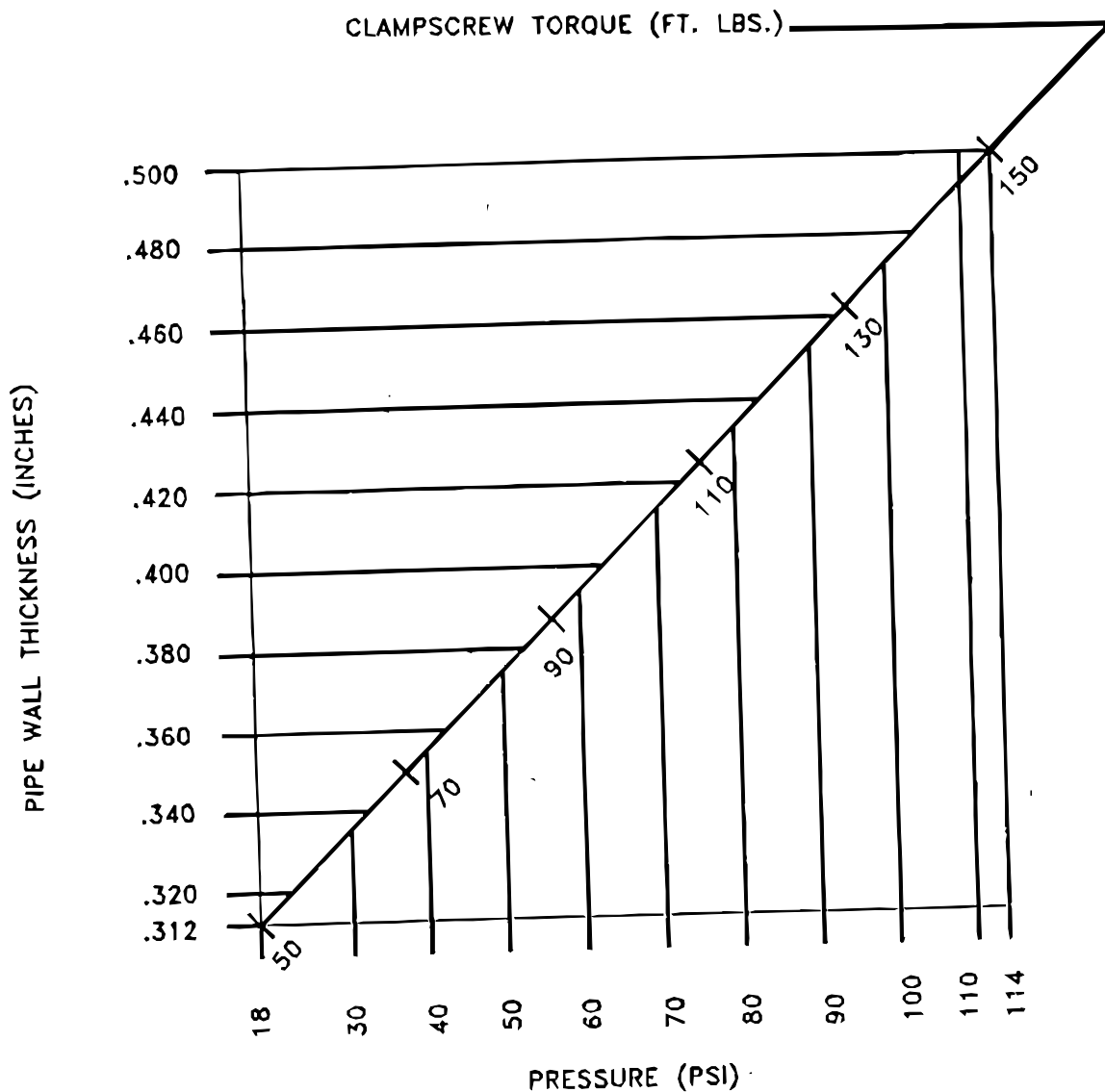
Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (MAOP) Ratings
36" Standard PLIDCO Weld+Ends on Thin Wall Pipe**



Attachment 3 (Continued)

Maximum Allowable Operating Pressure (MAOP) Ratings
40" Standard PLIDCO Weld+Ends on Thin Wall Pipe



Attachment 3 (Continued)

**Maximum Allowable Operating Pressure (Maop) Ratings
48" Standard PLIDCO Weld+Ends on Thin Wall Pipe**

