

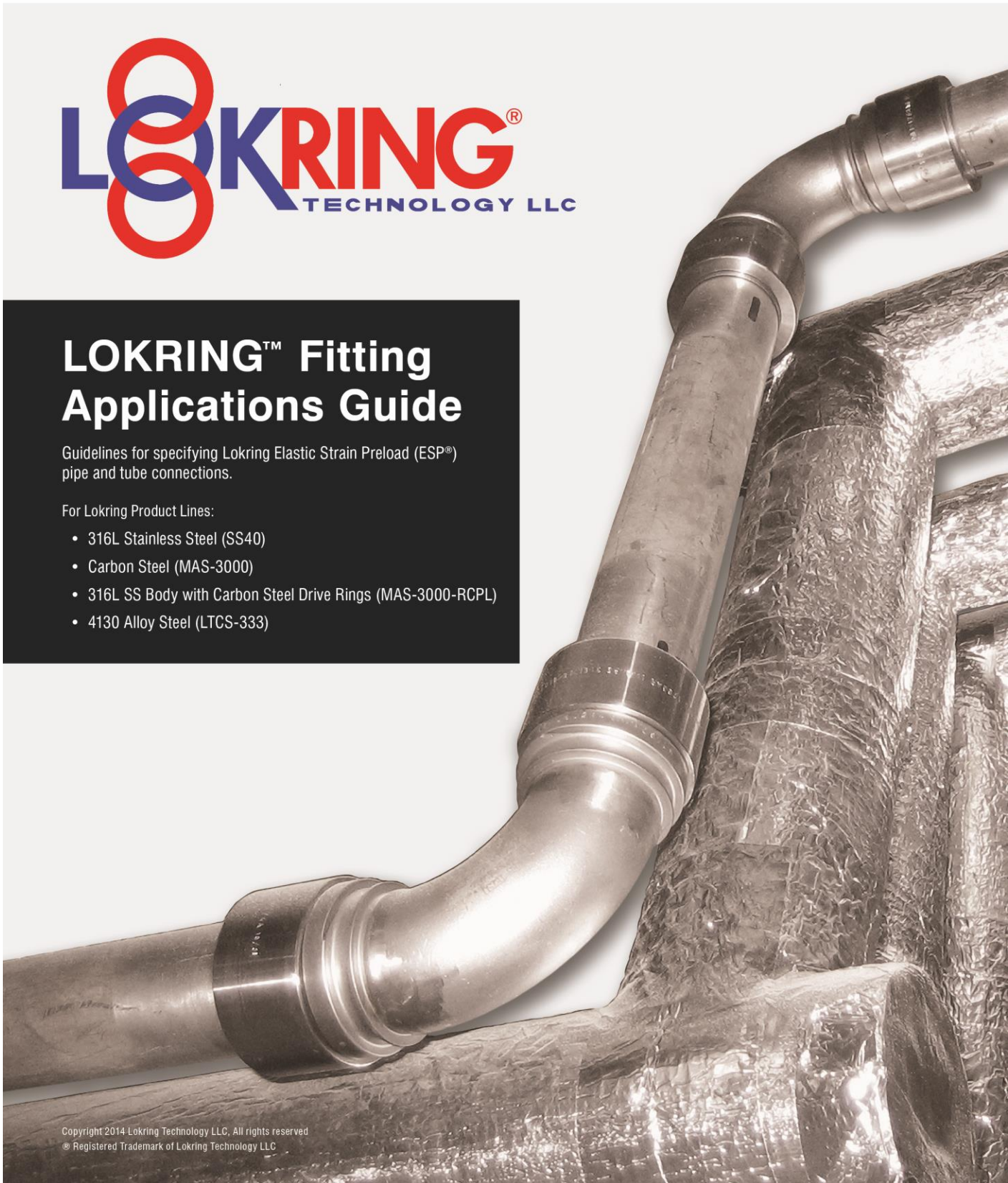


LOKRING™ Fitting Applications Guide

Guidelines for specifying Lokring Elastic Strain Preload (ESP®) pipe and tube connections.

For Lokring Product Lines:

- 316L Stainless Steel (SS40)
- Carbon Steel (MAS-3000)
- 316L SS Body with Carbon Steel Drive Rings (MAS-3000-RCPL)
- 4130 Alloy Steel (LTCS-333)



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Appendix A: Lokring Application Data Form (ADF)

1.0 Scope

This document, the "Lokring Fitting Applications Guide," is provided as a service to our customers and is intended to provide information pertaining to the usage and service limitations of Lokring™ fittings in process piping systems and their auxiliaries and utilities.

Lokring recognizes that while its products may be considered for a wide variety of services, it cannot provide specific performance information for every application. Therefore, the system designer, owner, and user must assume final responsibility for proper evaluation and application of Lokring products. If uncertain about whether or not Lokring fittings should be used for specific application, consult your piping specialist, corrosion specialist, and Lokring Technology.

Guidelines and corrosion considerations for the use of Lokring fittings are discussed in Sections 4 and 8. This document also contains information on the pipe grades for which the Lokring product has been qualified according to ASME B31. For more information specific to design and temperature ratings, please refer to the Lokring Fitting Specification, "FS" document, for the individual product lines.

Safe Selection Guide

When selecting Lokring fittings for use in any application, total system design must be considered to ensure safe, trouble free performance. Material compatibility, system pressure and temperature ratings, adequate corrosion control or allowances, control of fluid velocities, fluid chemical treatment, proper installation, operation, maintenance, and overall system safety are the responsibility of the system designer, owner, and operator.

2.0 The Lokring Elastic Strain Preload (ESP) Product Design Technology

Lokring fittings use a patented, elastic strain preload (ESP) technology to connect small diameter piping and tubing without threading or welding. Lokring fittings are designed to be used for field fabrication, for rapid repair, for installation in tight access areas, and for tie-ins of shop fabricated piping. The installation of Lokring fittings is simple, repeatable, and can be made in a fraction of the time required to weld the connection.

Fittings are installed with simple hydraulic tooling and form a leak-tight, metal-to-metal seal without O-rings or other elastomeric seals. The fittings are installed without hot work or open flame, making them ideal for installations in operating areas where welding is not feasible due to explosive atmospheres, etc. and where the use of a threaded connection is not acceptable. Because they require no hot work, the installation of Lokring fittings is the preferred method to connect pipe and tube than that of welding.

Following insertion of the pipe end into the fitting, hydraulic tooling is used to advance the drive ring axially over the fitting body, radially compressing (swaging) the fitting body on to the outside diameter (OD) of the pipe. As the pipe is compressed first elastically and then plastically by the swaging action during installation, circumferential sealing lands, machined in the bore of the fitting body, grip and seal on the pipe OD, forming a gas-tight, metal-to-metal seal without O-rings or other elastomeric seals. The diagram below shows the sealing lands on the coupling fitting body inside surface, indenting the pipe OD.

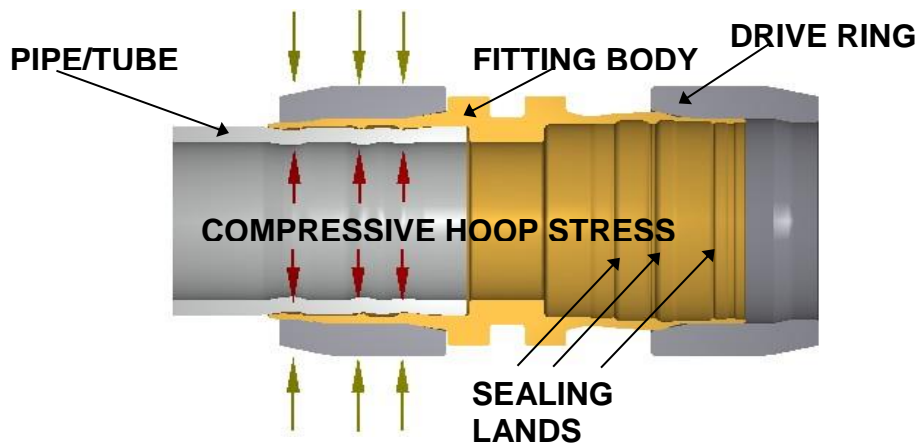


Diagram of Installed and Sectioned Lokring Fitting/Pipe

Table 1: Product Line Fitting Materials and Qualified for Pipe Sizes and Schedules.

Product Line	Fitting Material		Product Qualified for	
	Body	Drive Ring	NPS, in.	Pipe Schedule
316L SS (SS40)	316L SS	316L SS	1/4 to 3	10, 40, 80
Carbon Steel (MAS-3000)	Microalloyed carbon steel	Microalloyed carbon steel	1/4 to 4	40, 80
			1/2 to 1	160
MAS-3000-RCPL	316L SS	Microalloyed carbon steel	1/4 to 3	40, 80
4130 alloy steel (LTCS-333)	4130 alloy steel	4130 alloy steel	1/2 to 4	40, 80
			1/2 to 2	160
			1/2 to 3/4	XXS

3.0 Application of Lokring Products in Piping Systems and Services

3.1 Piping Systems

The ASME B31 Rules for the Process Piping Code Section B31.3 have been developed considering piping handling fluids typically found in:

- Chemical plants
- Loading terminals
- Bulk plants
- Tank farms
- Food processing
- Pulp & paper mills
- Upstream production (e.g. Offshore/Onshore)
- Midstream production
- Petroleum refineries
- Natural gas processing plants
- Compounding plants
- Steel mills

The ASME B31 Code prescribes requirements for materials and components, design, fabrication, assembly, erection, examination, inspection, and testing of piping systems. The ASME B31.3 Code applies to piping for all fluids, categorized as:

- Raw, intermediate, and finished chemicals
- Petroleum products
- Gas, steam, air, and water
- Fluidized solids
- Refrigerants
- Cryogenic fluids

Lokring fittings are also qualified for use in piping systems governed by other Sections of the ASME B31 Code for Pressure Piping including the requirements for the following applications:

- B31.1 Power Piping
- B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
- B31.8 Gas Transmission and Distribution Piping Systems
- B31.9 Building Services Piping.

3.2 Piping Systems and Services

The following is a list of piping systems and services where Lokring product lines 316L stainless steel (SS40), carbon steel (MAS-3000), 316L stainless steel body with carbon steel drive rings (MAS-3000-RCPL), and 4130 alloy steel (LTCS-333) have been used in industry within operating temperature/pressure and corrosion considerations for the product line. Because Lokring cannot anticipate or control operating conditions or system fluids, this list is not a recommendation for use in any specific system. Please refer to the "Safe Selection Guide."

Table 2: Piping Systems and Services Where Lokring Product Lines have been Used, ✓

	Piping Systems/Services	SS40	MAS-3000	MAS-3000-RCPL	LTCS-333
Raw, intermediate, and finished chemicals	Fire suppression foam	✓	✓	✓	✓
	Paint systems	✓	✓	✓	✓
	Chemical injection systems	✓	✓	✓	✓
	Chemical vent lines	✓	✓	✓	✓
	Product loading lines	✓	✓	✓	✓
	Sample stations	✓	✓	✓	✓
	Surfactant solutions	✓	✓	✓	✓
Petroleum products ① ②	Hydraulic and lubricating oils	✓	✓	✓	✓
	Hydrocarbon solvents	✓	✓	✓	✓
	Distillates and aromatics	✓	✓	✓	✓
	Production sour crude oil	✓			✓
	Fuel gas	✓	✓	✓	✓
	Fuel oil	✓	✓	✓	✓
	Chemical vent lines	✓	✓	✓	✓
	Hazardous vent/drain lines	✓	✓	✓	✓
Gas, steam, air, and water ① ② ③	Non-hazardous vent/drain lines	✓	✓	✓	✓
	Supplied natural gas	✓	✓	✓	✓
	Gas dehydration	✓	✓	✓	✓
	Flare headers and laterals	✓			✓
	Steam, condensate and drain lines	✓	✓	✓	✓
	Boiler feed and blow down water	✓	✓	✓	✓
	Steam tracing	✓	✓	✓	✓
	Breathing air	✓	✓	✓	✓
	Compressed air- process, instrument, utility	✓	✓	✓	✓
	Air dryers	✓	✓	✓	✓
	Water: cooling, utility, fire	✓	✓	✓	✓
	Water: potable	✓			
	Water treating systems	✓	✓	✓	✓
	Fire deluge ④	✓	✓	✓	✓
	Vacuum lines	✓	✓	✓	✓
Fluidized solids	Viscous organics	✓	✓	✓	✓
	Hot resins	✓	✓	✓	✓
	Waste solvents	✓	✓	✓	✓
Refrigerants	Heat transfer services	✓	✓	✓	✓
	Glycol vent/drain lines	✓	✓	✓	✓
	Cooling water lines	✓	✓	✓	✓
Cryogenic fluids	Flowing medium at temperatures lower than -150°F (-101°C): ethylene, oxygen, and nitrogen.	✓			

- ① Do not use Lokring carbon steel fittings in “sour” process or utility services and systems. For Lokring stainless steel fittings with qualified carbon steel pipe in sour services, see the conditions outlined in Sections 6 through 11.
- ② The user should evaluate Lokring fittings when high concentrations of caustic, CO, CO₂, ammonia, chlorine, and/or amines are present.
- ③ Lokring offers a 316L stainless steel (SS40) product (-PW) that is cleaned and passivated.
- ④ Lokring offers 90/10 and 70/30 copper nickel product solutions.

4.0 Service Limitations

4.1 Types of Services for Which Lokring Products are Designed

It is the designer, owner, and user's responsibility to evaluate the suitability of Lokring fittings for any applications. Lokring fittings meet the requirements of ASME B31.3 Category D and Normal Fluid Services for which the Lokring fittings are designed, developed, and qualified.

Lokring fittings also are designed, developed, and qualified for use on Boiler External Piping after the first valve connection of an ASME stamped boiler, furnace, or heater external piping, or on external pipes in jacketed piping systems.

4.2 Types of Services for Which Lokring Products are Not Suggested

Lokring fittings are not suggested for use in:

- Category High Pressure Fluid Service—A fluid service for which the owner specifies the use of Chapter IX for piping design and construction (ref. ASME B16.5 Class 2500 and higher).
- Category M Fluid Service—A fluid service in which the potential for personnel exposure is judged to be significant and in which a single exposure to a very small quantity of a toxic fluid, caused by leakage, can produce serious irreversible harm to persons on breathing or bodily contact, even when prompt restorative measures are taken.
- Category Severe Cyclic Fluid Services—A fluid service where conditions applying to specific piping components or joints in which S_E computed in accordance with ASME B31.3 para. 319.4.4 exceeds $0.8 S_A$ (as defined in para. 302.3.5), and the equivalent number of cycles (N in para. 302.3.5) exceeds 7000; or other conditions that the designer determines will produce an equivalent effect.

Lokring fittings shall not be used for Boiler External Piping between the boiler and first valve.

4.3 Types of (Chemical) Services for Which Lokring Products are Designed

The following is a guide of some services considered corrosive and or toxic where Lokring product lines SS40, MAS-3000, MAS-3000-RCPL, and LTCS-333 have been used in industry within operating temperature/pressure and corrosion considerations for the product line. Also identified are services where the use of Lokring fittings is not recommended.

Table 3: Chemical Services Where Lokring Product Lines have been Used, ✓, and Where Lokring Product Lines are Not Recommended, NR.

Service	SS40	MAS-3000	MAS-3000-RCPL	LTCS-333
Chlorine	NR	NR	NR	NR
Hydrochloric acid	NR	NR	NR	NR
Hydrofluoric acid	NR	NR	NR	NR
Carbonic acid	NR	NR	NR	NR
Sulfuric acid (concentration specific) ①	✓	NR	NR	NR
Hydrogen sulfide ① ②	✓	NR	NR	✓
Caustic ① ③	✓	✓	✓	✓
Clean hydrogen ① ④	✓	✓	✓	✓
Sour caustic ① ② ③	✓	NR	NR	✓
Sour hydrogen ① ② ③	✓	NR	NR	✓
Sour water ① ②	✓	NR	NR	✓
Chloride-contaminated water ① ⑤	✓	NR	NR	NR
Amines ①	✓⑥	NR	NR	
Anhydrous ammonia ①		NR	NR	NR

- ① Please complete Lokring Application Data Form (See copy in Appendix A). For anhydrous applications, please confirm design as moisture (H₂O) can easily be introduced and affect conditions.
- ② Do not use Lokring MAS-3000 (carbon steel) fittings on hydrogen sulfide services, or “sour” services. Stainless steel fittings should be evaluated for use on qualified carbon steel pipe up to 300# ASME flange class pressure rating maximum provided post-weld stress relief of welded joints is not required for system.
- ③ Only if service conditions are below the temperature and caustic concentrations required for stress relief according to the NACE caustic service graph.
- ④ Use only within the carbon steel portion of the Nelson curve for Lokring MAS-3000 (carbon steel) fittings and pipe. Do not use for high temperature applications. Reference API 941.
- ⑤ If chloride concentration and service temperature is high continuous or transient, then do not install Lokring stainless steel fittings.
- ⑥ Lokring SS40 fittings have seen limited use in amine service. As such, please complete the Lokring Application Data Form (See copy in Appendix A).

4.4 Additional Guidance is Available from Lokring

As always, when in doubt about the use of Lokring in an application, consult your piping corrosion specialist. We also encourage you to review your application with Lokring where additional experience and guidance is available upon request. You can do this by utilizing the Lokring Applications Data Form (See Appendix A) to outline your specific application details. Please complete this document and forward to your local Lokring Technology distributor for Lokring to process and provide a response to your application questions.

5.0 Qualification to the ASME Code

The various ASME B31 Book Sections (e.g., the B31.1 Power Piping Code, the B31.3 Process Piping Code, etc.) have requirements with which non-standard piping product forms can be qualified for use in piping systems which are intended to meet the respective rules of those code guidelines and requirements. Lokring products have been designed, developed, and qualified for use in piping systems designed to the ASME B31 code. Lokring products are qualified to the B31 code for:

- Pressure design in accordance with ASME B31H (DRAFT) Standard Method to Establish Maximum Allowable Pressure for Metallic Piping Components.
- Cyclic fatigue design in accordance with ASME B31J Standard Test Method for Determining Stress Intensification Factors (i-Factors) for Metallic Piping Components.
- Fitting design (welded assemblies) in accordance with ASME Section IX Welding and Brazing Qualifications for Category D Fluid Service and Normal Fluid Service. (Lokring Standard 5 % RT with 100 % RT optional).
- Fitting material in accordance with ASME BPVC Section II.

The paper, "Qualification of Non-standard Product Form for ASME Code for Pressure Piping, B31 Applications," a copy of which is available upon request, was published in the Codes and Standards Applications for Design and Analysis of Pressure Vessel and Piping Components, PVP-Vol. 210-1, American Society of Mechanical Engineers, New York 1991. This paper explains the methods used to qualify the Lokring fitting to the ASME Code for Pressure Piping.

Also available for review is the Lokring publication, A Guideline for Designing ASME B31 Pressure Piping Using Lokring™ Elastic Strain Preload (ESP®) Fittings.

6.0 System Design Pressure and Temperature and the Use of Lokring Fittings

The design pressure rating of any piping system is set by the pressure limiting component within the system. Pressure ratings of Lokring fittings (except for Lokring ASME flange fittings whose pressure rating may be limited by ASME B16.5 limitations) are specifically determined in an assembly with matching pipe, and they may, or may not, be the pressure limiting component in that system.

Lokring fittings are to be used in services within their pressure-temperature rating, within the vacuum rating of the joined pipe, and with fluid compatible with the fitting's materials of construction. The allowable working pressures of Lokring fittings on qualified matching pipe sizes and wall thickness (schedules) under the respective rules of ASME B31.1 and B31.3 are presented in the Lokring Fitting Specification, "FS" documents, listed in Table 4.

Table 4: System Design Ratings for Pressure and Temperature When Using Specific Lokring Products.

Product Line	Product Qualified for		Design Rating for	
	NPS in.	Pipe Schedules	Pressure, Refer to Lokring Fitting Specification	Temperature Limited to °F (°C) max.
SS40	1/4 to 3	10, 40, 80	FS-40	800 (427)
MAS-3000	1/4 to 4	40, 80	FS-3000	650 (343)
	1/2, 3/4, 1	160		
MAS-3000-RCPL	1/4 to 3	40, 80	FS-3000-RCPL	650 (343)
LTCS-333	1/2 to 4	40, 80	FS-333	800 (427)
	1/2 to 2	160		
	1/2 to 3/4	XXS		

As an additional service to our customers, guidelines for the compatibility of Lokring SS40, MAS-3000, and LTCS-333 products in piping systems whose pressure ratings are governed by ASME flange pressure-temperature ratings are provided in the section specific to each product line in this document.

7.0 Pipe Grades/Types Qualified for Use with Lokring Fittings

7.1 Stainless Steel Pipe

Lokring 316L stainless steel (SS40) fittings are qualified for usage when installed on seamless and welded stainless steel pipe to ASTM A312 Grades 304, 304L, 316, and 316L. See the Lokring Fitting Specification FS-40 for details on matching pipe specifications, sizes, and schedules.

Stainless steel fittings should not be used with galvanized piping or carbon steel piping coated with zinc-rich coatings in flammable service subject to fire damage.

The use of Lokring carbon steel products to connect stainless steel pipe is not suggested.

7.2 Carbon Steel Pipe

Lokring carbon steel (MAS-3000) fittings are qualified for usage when installed on seamless and welded (electric resistance welded) carbon steel pipe to ASTM A106 Grade B and ASTM A53 Grade B, Type S and E. See the Lokring Fitting Specification FS-3000 for details of matching pipe specifications, sizes, and schedules.

Lokring 4130 alloy steel (LTCS-333) fittings are qualified for usage when installed on seamless and welded (electric resistance welded) carbon steel pipe to ASTM A333 Grade 6, ASTM A106 Grade B, and ASTM A53 Grade B, Type S and E and API 5L Grade B. See the Lokring Fitting Specification FS-333 for more details on the matching pipe specifications, sizes, and schedules.

Lokring 316L stainless steel (SS40) fittings can be used to connect carbon steel pipe within the pressure-temperature limitations listed in FS40.

When connecting stainless piping with carbon steel piping, only 316L stainless steel Lokring fittings should be used.

Lokring 316L stainless steel (SS40) fittings are qualified for use on carbon steel pipe to ASTM A106 Grade B and ASTM A53 Grade B, Type S and E. The effect of galvanic corrosion has proven to be negligible with Lokring SS40 fittings installed on carbon steel pipe. Pressure and temperature ranges are defined by FS40 or the limiting values for the pipe used.



Refer to the following Table 5 for a summary of the Pipe Specifications and Grades the Lokring SS40, MAS-3000, and LTCS-333 are qualified for use on ("Yes") and not qualified for use on ("No"):

Table 5: Pipe Specification and Grade and Applicable Lokring Product Line.

Product Line	Pipe Specification and Grade						Product Qualified for	
	ASTM A312 TP304/304L	ASTM A312 TP316/316L	ASTM A53 Grades A and B (seamless and welded) A587	ASTM A106 Grades A and B	API 5L Grade B	ASTM A333 Grade 6	NPS in.	Pipe Schedules
SS40	Yes	Yes	Yes	Yes	Yes	No	1/4 to 3	10, 40, 80
MAS-3000	No	No	Yes	Yes	No	No	1/4 to 4	40, 80
							1/2, 3/4, 1	160
MAS-3000-RCPL	No	No	Yes	Yes	Yes	No	1/4 to 3	40, 80
LTCS-333	No	No	Yes	Yes	Yes	Yes	1/2 to 4	40, 80
							1/2 to 2	160
							1/2 to 3/4	XXS

8.0 Corrosion Considerations for Lokring Fittings and Joined Pipe

The unique design and sealing mechanism of Lokring fittings, and their materials of construction, suggest that a user analysis before installation be made of the effects of corrosion on the Lokring fitting and joined pipe. This section provides guidelines for Lokring products for general corrosion, localized (crevice) corrosion, and the potential in some services for environmentally induced cracking of the Lokring fitting material or joined pipe.

8.1 Establish the System Conditions

Because of the large number of factors which can affect corrosion in piping system (including, but not limited to materials, fluid concentration, temperature, presence of impurities and aeration), it is suggested that before selecting Lokring for a specific service, a more extensive investigation be made of published corrosion results under the specific conditions expected. When uncertain about the suitability of Lokring fittings for a specific application, consult your piping and/or corrosion specialist.

8.2 Lokring Fitting Design Considerations for the Effects of Corrosion

The body design of the Lokring fitting requires that a section of its wetted wall thickness be less than that of the connected pipe. This section of the fitting body is reinforced for hoop direction pressure stresses by the installation of the drive ring over the fitting body which is not directly exposed to the service media flow. The primary sealing and strength portion of the fitting is protected from corrosion by the inside sealing land.

Fittings such as elbows and tees have minimum wall thickness at all points which are exposed to the flow velocity (and its erosive effects) which match or exceed schedule 80 pipe for MAS-3000 carbon steel fittings and LTCS-333, 4130 alloy steel fittings and schedule 40 pipe for 316L stainless steel (SS40) fittings.

8.3 Corrosion Guidelines

When selecting piping system materials, considerations should be given to allowances made for temperature and pressure effects of process reactions, for properties of the reaction or decomposition products, and for hazards from instability of contained fluids. Selection of materials to resist deterioration in service is the responsibility of the designer, owner, and operator. Information on material performance in corrosive environments can be found in publications, such as "The Corrosion Data Survey" published by the National Association of Corrosion Engineers.

For stainless steel piping systems when fluid corrosion rate exceeds 0.002 inch year (0.05 millimeter/year) and the specified piping corrosion allowance exceeds 0.050 inch (1.27 millimeter) the use of Lokring 316L stainless steel (SS40) fittings is not suggested.

- MAS-3000 product is designed for carbon steel piping systems with corrosion allowance of 1/16 inch (1.6 millimeter).
- MAS-3000-RCPL product is designed for carbon steel piping systems with corrosion allowance of 1/16 inch (1.6 millimeter).
- LTCS-333 product is designed for carbon steel piping systems with corrosion allowance of 1/8 inch (3.2 millimeter).

For services known to:

- be Toxic or Lethal (Category M)
 - Lokring suggests that Lokring fittings not be used in toxic and/or lethal services identified as "Category M" as defined by the ASME B31.3 piping code.
- promote stress corrosion cracking
 - Lokring MAS-3000 fittings are not to be used in piping system services requiring stress relief of welded joints (Post weld heat treatment "PWHT"). There are some services where the Lokring SS40 and LTCS-333 product lines can be used based on successful results of testing according to NACE TMO177 and field service. Further details on suitability for specific applications are explained further in the following sections for each product line.
 - Care should be taken to avoid direct contact of steam heat tracing elements with the Lokring coupling or drive ring for services where stress corrosion cracking at elevated temperatures can occur, such as with caustic soda. For these services, it is strongly suggested that standoffs be placed on the drive rings before the tracing is applied. With the standoffs, Lokring fittings may be completely covered with insulation. Electric heat tracing does not normally operate at temperatures known to cause problems.
- promote crevice or localized corrosion
 - The use of SS40 and MAS-3000 Lokring fittings in services where crevice corrosion is considered a problem should be avoided. Lokring has conducted testing for crevice corrosion based on ASTM G78 and NACE TMO177 and provides evidence that Lokring LTCS-333 product line may be used in these environments.

As always, when in doubt, consult your piping corrosion specialist and/or Lokring Technology for additional information.

9.0 316L Stainless Steel (SS40) Fittings

9.1 Product Design and Material

The Lokring 316L stainless steel (Series SS40) fitting design is constructed of ASTM A312 TP316/316L, typically known as “dual certified” material.

Lokring 316L stainless steel (SS40) 90° and 45° elbows are fabricated using ASME B16.9 schedule 40 long radius butt weld fittings. Tees are fabricated either from B16.9 schedule 40 butt weld fittings, or machined from forgings. Lokring flanged fittings are fabricated using ASME B16.5 weld neck flanged components. The flow characteristics of 316L stainless steel Lokring fittings are similar to schedule 40 butt weld fittings.

Lokring welded product (shapes) are manufactured to ASME B31.3 Normal Services, <750°F (400°C). Lokring does offer product that is manufactured and inspected to 100 % radiography to B31.3 Normal Service acceptance criteria. This product is identified and ordered by adding the suffix “-XR.”

9.2 Qualified Pipe

Lokring 316L stainless steel fittings are qualified for usage when installed on seamless and welded stainless steel pipe to ASTM A312 Grades 304, 304L, 316, and 316L. See the Lokring Fitting Specification FS-40 for details of qualified matching pipe specifications, sizes, and schedules.

Lokring 316L stainless steel fittings are qualified for use on carbon steel pipe to ASTM A106 Grade B and ASTM A53 Grade B, Type S and E. Pressure and temperature ranges are defined by FS40 or the limiting values for the pipe used.

When connecting stainless piping with carbon steel piping, only 316L stainless steel Lokring fittings should be used.

Stainless steel fittings should not be used with galvanized piping or carbon steel piping coated with zinc-rich coatings in flammable service subject to fire damage.

9.3 Design Ratings

Design pressure ratings. See the Lokring Fitting Specification FS-40 for pressure ratings.

Design temperature ratings. Lokring 316L stainless steel (SS40) fittings are rated between temperatures of –150 to 800°F (–101 to 427°C). Lokring Series SS40 is limited to the low-temperature limits of the applicable B31 Code. In B31.3 services, Lokring Series SS40 straight couplings and fittings that do not contain a weld are rated to –425°F (–254°C) when joining ASTM A312 Grades TP 304, TP304L, TP316, and TP 316L pipe. However, in B31.3 services, Lokring Series SS40 special fittings (e.g. 90° elbow or tee) having welds are rated to –150°F (–100°C) when joining ASTM A312 Grades TP 304, TP304L, TP316, and TP 316L pipe.

9.4 Corrosion Considerations

The low-carbon, 316L grade of stainless steel used in stainless steel Lokring fittings requires no special corrosion consideration beyond those required for 316 stainless steel in general. Lokring fittings, particularly the drive rings, should be protected from external stress corrosion cracking environments. Lokring fittings should be coated after installation, if the connected pipe is coated.

Lokring 316L stainless steel (SS40) fittings are not to be used in services with high chloride concentrations and operating temperatures. Studies done on austenitic stainless steels indicate that susceptibility to chloride pitting of those materials is determined by a number of environmental and component parameters. Temperature is an important variable in determining chloride pitting; the threshold for initiation of stress corrosion cracking in austenitic steels, which has been shown to be 120 to 140°F (49 to 60°C) for annealed material. Temperature for initiation of stress corrosion cracking is linked to chloride concentration.

Because of the excellent corrosion resistance of the 316L stainless steel fitting body, Lokring stainless steel fittings may be suitable as an alternative to carbon steel fittings for carbon steel piping services with corrosion rates higher than 3 mil/year or corrosive allowances greater than 1/16 inch (1.6 millimeter).

When installing 316L stainless steel fittings on carbon steel pipe, the pressure-temperature (and wall thickness) limitations of the Lokring Fitting Specification FS-40 should be reviewed and followed.

Stress Corrosion Cracking-

The cold working of the stainless steel pipe to effect the seal of Lokring fitting creates axial tensile stresses circumferentially in the pipe on the inside diameter at the point of deformation. These stresses may be sufficient to cause stress corrosion cracking of the stainless steel pipe.

Additionally, the non-L (or low) carbon grades of stainless steel piping may become sensitized if the temperature is cycled above 800°F (427°C). The cold-worked areas provide preferential sites for chromium carbide precipitation and possible intergranular attack. The amount of cold work in this area increases as the pipe wall thickness decreases.

Field Experience

Actual experience of Lokring fittings in some services indicate they may have a tolerance to higher piping general corrosion rates than is indicated by the non-corrosive services listed in Table 2 of this guide. Contact Lokring for further information. For known short-term, or temporary applications, the user can evaluate the effects of corrosion and service time to determine suitability of Lokring fittings.

10.0 Carbon Steel (MAS-3000) Fittings

10.1 Product Design and Material

The Lokring carbon steel (MAS-3000) product fitting bodies and drive rings are manufactured from hot-rolled, microalloyed carbon steel bar or drawn-over-mandrel, stress relieved mechanical tubing. Bar stock material conforms to ASTM A675 and the chemical and mechanical properties conforms to LOKRING material specification LMS 92-10. Mechanical tube stock material conforms to ASTM A513 / DIN 2393 grade ST 52.3 and the chemical and mechanical properties conforms to LOKRING material specification LMS 97-20.

Lokring Series MAS-3000 carbon steel fittings are either fabricated from ASME B16.9 schedule 80 butt weld fittings, or machined from forgings. Lokring MAS-3000 flanges are fabricated using ASME B16.5 weld neck raised face flanges. The flow characteristics of Lokring carbon steel fittings are similar to schedule 80 butt weld fittings.

Lokring welded product (shapes) are manufactured to ASME B31.3 Normal Services. Lokring does offer product that is manufactured and inspected to 100 % radiography to B31.3 Normal Service acceptance criteria. This product is identified and ordered by the suffix “-XR.”

For shelf-life corrosion protection the MAS-3000 fittings are subjected to a black-oxide process, followed by a rust inhibiting dip.

10.2 Qualified Pipe

Lokring MAS-3000 carbon steel fittings are qualified for usage when installed on seamless and welded (electric resistance welded) carbon steel pipe to ASTM A106 Grade B and ASTM A53 Grade B, Type S and E. See Lokring product specification FS-3000 for details of matching pipe specifications, sizes, and schedules.

Contact Lokring if pipe materials or grades of materials other than described in this guide are specified to be used with Lokring products.

The use of Lokring carbon steel products to connect stainless steel pipe is not suggested. However, Lokring 316L stainless steel fittings can be used to connect carbon steel pipe within the pressure-temperature limitations outlined in the Lokring Fitting Specification FS-40. When connecting stainless piping with carbon steel piping, only 316L stainless steel Lokring fittings should be used. Contact Lokring if materials or grades of materials other than described in this guide are specified to be used with Lokring products.

10.3 Design Ratings

Design pressure ratings. See the Lokring Fitting Specification FS-3000 for pressure ratings.

Design temperature ratings. Lokring MAS-3000 carbon steel fittings are rated for use between temperatures of -20 to 650°F (-29 to 343°C)

10.4 Corrosion Considerations

The microalloyed carbon steel used in Lokring MAS-3000 carbon steel fittings should be treated the same as the qualified pipe grades of steel for general corrosion resistance and corrosion rates. The fittings should be protected from external corrosion by the same coatings used to protect the piping.

Inorganic zinc primer applied to carbon steel pipe as corrosion protection prior to installation of Lokring fittings does not have to be removed during installation process provided the coating is 3.0 mils (0.076 millimeters) or less. Top coating of the fitting and piping after installation of the Lokring fitting is suggested, but not required, for protection from surface corrosion caused by external environment conditions.

Lokring have also previously conducted accelerated Salt Spray testing to ASTM B117 that included corrosion analysis and burst tests. The test report, images, and certification are available.

Stress Cracking

The high minimum yield strength and hardness of the material used to make Lokring carbon steel fittings may exclude its usage in fluids where environmentally induced sulfide stress cracking (SSC) can occur, such as hot caustic or sour services. The Lokring 316L stainless steel fitting may be considered a substitute for the carbon steel fitting.

When caustic is present in steam lines, limit use of Lokring carbon steel fittings to steam services 200 psig (1.37 MPa) or lower.

The cold working of the pipe to effect the seal of the Lokring diameter creates axial tensile stresses circumferentially in the pipe on the inside diameter at the point of deformation. These stresses may be sufficient to cause cracking of the pipe in amine, hydrogen sulfide, hot caustic, and anhydrous ammonia services. Lokring MAS-3000 fittings are not to be used in piping system services requiring stress relief of welded joints (Post weld heat treatment "PWHT").

Field Experience

Actual experience of Lokring fittings in some services indicate they may have a tolerance to higher piping general corrosion rates than is indicated by the non-corrosive services listed in Table 2. Contact Lokring for further information. For known short-term, or temporary applications the effects of corrosion and service time can be evaluated to determine suitability of Lokring fittings.

11.0 316L Stainless Steel Body with Carbon Steel Drive Rings (MAS-3000-RCPL) Fittings

11.1 Product Design and Material

The Lokring carbon steel Series MAS-3000-RCPL fitting design is constructed of ASTM A312 TP316/316L, typically known as “dual certified” material for the fitting body. The drive rings are manufactured from hot rolled microalloyed carbon steel bar or drawn-over-mandrel, stress relieved mechanical tubing. Bar stock material conforms to ASTM A675 and the chemical and mechanical properties conforms to LOKRING material specification LMS 92-10. Mechanical tube stock material conforms to ASTM A513 / DIN 2393 grade ST 52.3 and the chemical and mechanical properties conforms to LOKRING material specification LMS 97-20.

The Lokring Series MAS-3000-RCPL product line consists of straight couplings only.

11.2 Qualified Pipe

Lokring MAS-3000-RCPL stainless/carbon steel fittings are qualified for usage when installed on seamless and welded (electric resistance welded) carbon steel pipe to ASTM A106 Grade B and ASTM A53 Grade B, Type S and E. See Lokring product specification FS-3000- RCPL for details of matching pipe specifications, sizes, and schedules.

Lokring MAS-3000-RCPL stainless/carbon steel fittings should not be used with galvanized piping or carbon steel piping coated with zinc-rich coatings in flammable service subject to fire damage.

Contact Lokring if materials or grades of materials other than described in this guide are specified to be used with Lokring products.

11.3 Design Ratings

Design pressure ratings. See the Lokring Fitting Specification FS-3000-RCPL for pressure ratings.

Design temperature ratings. Lokring MAS-3000-RCPL stainless/carbon steel fittings are rated for use between temperatures of -20 to 650°F (-29 to 343°C).

11.4 Corrosion Considerations

The low-carbon, 316L grade of stainless steel used in stainless steel Lokring fittings requires no special corrosion consideration beyond those required for 316 stainless steel in general. The fittings should be protected from external corrosion by the same coatings used to protect the piping.

Inorganic zinc primer applied to carbon steel pipe as corrosion protection prior to installation of Lokring fittings does not have to be removed during installation process provided the coating is 3.0 mils (0.076 millimeters) or less. Top coating of the fitting and piping after installation of the Lokring fitting is suggested, but not required, for protection from surface corrosion caused by external environment conditions.

Lokring MAS-3000-RCPL fittings are not to be used in services with high chloride concentrations and operating temperatures. Studies done on austenitic stainless steels indicate that a number of environmental and component parameters determines susceptibility to chloride pitting of those materials. Temperature is an important variable in determining chloride pitting; the threshold for initiation of stress corrosion cracking in austenitic steels has been shown to be 120 to 140°F (49 to 60°C) for annealed material. Temperature for initiation of stress corrosion cracking is linked to chloride concentration. Lokring 316L stainless steel fittings may be used in sour process and utility services up to 300# ASME flange class pressure rating.

Because of the excellent corrosion resistance of the Lokring 316L stainless steel fitting body, Lokring MAS-3000-RCPL fittings may be suitable as an alternative to carbon steel fittings for carbon steel piping services with corrosion rates higher than 3 mil/year (0.076 millimeters/year) or corrosive allowances greater than 1/16 inch (1.6 millimeter).

When installing 316L stainless steel fittings on carbon steel pipe, the pressure-temperature (and wall thickness) limitations of the Lokring Fitting Specification FS-3000-RCPL should be reviewed and followed.

Stress Cracking

Sulfide stress cracking (SSC) testing of the microalloyed carbon steel to NACE TMO177, Method A, indicates that the material is susceptible to stress corrosion cracking in hydrogen sulfide (sour gas) services. As a precaution from the possibility of exposure of the drive rings to sour gas from the environment the Lokring MAS-3000-RCPL fittings should not be used in any sour gas system.

The cold working of the pipe to effect the seal of the Lokring diameter creates axial tensile stresses circumferentially in the pipe on the inside diameter at the point of deformation. These stresses may be sufficient to cause cracking of the pipe in amine, hydrogen sulfide, hot caustic, and anhydrous ammonia services. Lokring MAS-3000-RCPL fittings are not to be used in piping system services requiring stress relief of welded joints (post-weld heat treatment, "PWHT").

Field Experience

Actual experience of Lokring fittings in some services indicate they may have a tolerance to higher piping general corrosion rates than is indicated by the non-corrosive services listed in Table 2 of this guide. Contact Lokring for further information. For known short term, or temporary applications the effects of corrosion and service time can be evaluated to determine suitability of Lokring fittings.

12.0 4130 Alloy Steel (LTCS-333) Fittings

12.1 Product Design and Material

The 4130 alloy steel (LTCS-333) fitting bodies and drive rings are manufactured from bar or mechanical tubing. Bar stock and forged material conforms to ASTM A29 Grade 4130. Mechanical tubing conforms to ASTM A519. The mechanical properties conform to LOKRING material specification LMS 97-22, 09-02, 10-01, and 10-03.

Lokring LTCS-333 flanges are fabricated as a one-piece construction and compliant with ASME B16.5 Pipe Flanges and Flanged Fittings and MSS SP 44 Standard Practice for Steel Pipe Flanges. With the exception of the short radius 90 degree forged elbows, the flow characteristics of Lokring LTCS-333, 4130 alloy steel fittings are similar to schedule 80 butt weld fittings.

For shelf-life corrosion protection, the LTCS-333 fittings are zinc coated.

12.2 Qualified Pipe

Lokring LTCS-333, 4130 alloy steel fittings are qualified for usage when installed on seamless and welded (electric resistance welded) carbon steel pipe to ASTM A106 Grade B and ASTM A53 Grade B, Type S and E; API 5L Grade B; and ASTM A333 Grade 6. See the Lokring Fitting Specification FS-333 for details of matching pipe specifications, sizes, and schedules.

Contact Lokring if pipe materials or grades of materials other than described in this guide are specified to be used with Lokring products.

The use of Lokring carbon steel products to connect stainless steel pipe is not suggested. However, Lokring 316L stainless steel fittings may be used to connect carbon steel pipe within the pressure-temperature limitations outlined in the Lokring Fitting Specification FS-40. When connecting stainless piping with carbon steel piping, only 316L stainless steel Lokring fittings should be used. Contact Lokring if materials or grades of materials other than described in this guide are specified to be used with Lokring products.

12.3 Design Ratings

Design pressure ratings. See the Lokring Fitting Specification FS-333 for pressure ratings.

Design temperature ratings. Lokring LTCS-333, 4130 alloy steel fittings are suggested to be used between temperatures of -50 to 400°F (-46 to 204°C).

12.4 Corrosion Considerations

General Corrosion Considerations

The 4130 alloy steel used in Lokring LTCS-333 fittings should be treated the same as the qualified pipe grades of steel for general corrosion resistance and corrosion rates. The fittings should be protected from external corrosion by the same coatings used to protect the piping.

Inorganic zinc primer applied to carbon steel pipe as corrosion protection prior to installation of Lokring fittings does not have to be removed during installation process provided the coating is 3.0 mils (0.076 millimeters) or less. Top coating of the fitting and piping after installation of the Lokring fitting is suggested, but not required, for protection from surface corrosion caused by external environment conditions.

Stress Cracking

Under controlled lab conditions, sulfide stress cracking (SSC) testing of the LTCS-333 product to NACE TMO177, Method A found "No evidence of cracking was observed on assembled Lokring mechanical connections internally exposed to NACE TMO177 Method A sour test solutions for 30 days. The 4130 alloy steel Lokring connections tested at 76°F (24°C) showed corrosion pitting but no sulfide stress cracking."

Field Experience

Actual experience of Lokring fittings in some services indicate they may have a tolerance to higher piping general corrosion rates than is indicated by the non-corrosive services listed in Table 2. Contact Lokring for further information. For known short-term, or temporary applications, the user can evaluate the effects of corrosion and service time to determine suitability of Lokring fittings.

Contact Lokring for available test data and field service information on sour gas and other sour services.



Sour Service Applications

In addition to the details on pipe specification, pipe grade, schedule, system pressure, and temperature we would like the following information in order to understand the application and provide additional information. Please use the Lokring Application Data Form, Appendix A.

What NACE standards are applicable to piping specification? _____

Is this a sour oil refinery application? Yes No (circle one)

Is this a sour oilfield application? Yes No (circle one)

Is this a sour application other than oil refinery or oilfield? Yes No (circle one)

If yes, describe the details of the application:

ppm by weight dissolved hydrogen sulfide (H₂S) in water?

Water pH? ___ pH

Does water have dissolved H₂S? Yes No (circle one)

Total system pressure? _____ psig MPa (circle one)

H₂S partial pressure? _____ psig MPa (circle one)

Presence of:

Hydrogen compounds? Yes No (circle one) If yes, please list:

Sulfur? Yes No (circle one)

Sea water? Yes No (circle one)



APPENDIX A: Lokring Application Data Form (ADF)

ADF Number _____

Please return your completed form to your authorized Lokring distributor or agent.

Date: _____

CUSTOMER INFORMATION

Company: _____
Contact name: _____
Phone: _____ E-Mail: _____

May we share this information with others at Lokring? Yes No
May we share your name as a contact with others? Yes No

SERVICE INFORMATION

Description of service (e.g. saturated steam): _____
Concentration (%) (e.g. nitric acid 10 %): _____
Approximate pH (0 to 14) Note: less than 7 is acidic / 7 is neutral / greater than 7 is a basic: ____
Can the service cause crevice corrosion? Yes No
Operating pressure (psig or MPa) Normal: _____ Maximum: _____
Operating temperature (°C or °F) Normal: _____ Maximum: _____
Continuous service? Yes No If No, what is the duty cycle? _____ cycles per _____
Known contaminants: _____

PIPE/TUBE INFORMATION

Stainless Steel Pipe/Tube

Pipe/Tube specification (A312, other): _____
Manufacturing process (seamless, ERW, other): _____
Type (304; 304L; 316; 316L; other): _____
Pipe/Tube size (NPS/OD/mm) (1/4 to 4 inch, other): _____
Pipe/Tube wall (schedule/wall/mm) (10, 40, 80, other): _____

Carbon Steel Pipe/Tube

Pipe/Tube specification (A105/6, A53, A587, A333, other): _____
Manufacturing process (seamless, electric welded, furnace welded): _____
Pipe grade (A, B, other): _____
Pipe/Tube size (NPS/OD/mm) (1/4 to 4 inch, other): _____
Pipe/Tube wall (schedule/wall/mm) (10, 40, 80, 160, other): _____
Corrosion protection (black iron, galvanized, other): _____

APPLICATION INFORMATION

Applicable regulatory agency (ASME, ABS, DNV, Lloyds, USCG, other): _____
Specified fabrication method (Lokring, butt weld, socket weld, screwed): _____
Specified welding process (TIG, stick, MIG, other): _____
Purge required? Yes No
Post-weld heat treat required? Yes No
Fire permit needed to weld? Yes No
Line corrosion allowance (amount in inch/millimeter): _____
Is the line heat traced? Yes No If yes, Steam Electric
Is the line painted? Yes No If yes, type of paint: _____
Is the line insulated? Yes No

Estimated average hourly labor rate _____



The following information shall be known when considering the use of Lokring LTCS-333 product for sour service applications:

What NACE standards are applicable to piping specification? _____

Is this a sour oil refinery application? Yes No (circle one)

Is this a sour oilfield application? Yes No (circle one)

Is this a sour application other than oil refinery or oilfield? Yes No (circle one)

If yes, describe the details of the application:

ppm by weight dissolved hydrogen sulfide (H₂S) in water?

Water pH? _____ pH

Does water have dissolved H₂S? Yes No (circle one)

Total system pressure? _____ psig MPa (circle one)

H₂S partial pressure? _____ psig MPa (circle one)

Presence of:

Hydrogen compounds? Yes No (circle one) If yes, please list:

Sulfur? Yes No (circle one)

Sea water? Yes No (circle one)