



## Innovative 'Cold Weld' Solution for Pipe Repairs and Construction

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# LOKRING: Our Clients

سابك

sabik

M  
MERCK MILLIPORE



أرامكو السعودية  
saudi aramco



Canadian Natural



Valero

sabik



Apache



أدنوك  
ADNOC

enQuest



gsk

Pfizer

DOOSAN

ExxonMobil

intel



BAE SYSTEMS

edf



TOTAL

equinor



Lucite International



Worley  
energy | chemicals | resources



GLOBAL ENERGY GROUP

DOW

petroineos  
REFINING AND TRADING

wood.

DSM

HUNTSMAN  
Enriching lives through innovation

INEOS  
THE WORD FOR CHEMICALS



BRITISH STEEL

ArcelorMittal



TATA



babcock

ESSAR



TRONOX

LOTTE CHEMICAL

syngenta

LIBERTY

NYNAS



# LOKRING: Materials



**Micro Alloyed Steel  
(MAS-3000)**

**Size Range:** ¼" to 4"

**Pipe Schedule:** 40-160

**Pipe Material:** A106 B, A53 B, API 5L,  
A333 Gr 6

**Corrosion Allowance:** 1.6mm



**Low Temp Carbon Steel  
(LTCS)**

**Size Range:** ¼" to 4"

**Pipe Schedule:** 40-XXS

**Pipe Material:** A106 B, A53 B, API 5L,  
A333 Gr 6

**Corrosion Allowance:** 3.2mm



**Stainless Steel (316/316L)  
(SS40)**

**Size Range:** ¼" to 3"

**Pipe Schedule:** 10 - 80

**Pipe Material:** A106 B, A53 B, API 5L,  
A333 Gr 6, 316/316L, 304

**Corrosion Allowance:** N/A



**Copper Nickel  
(CuNi)**

**Size Range:** M12 – M57

**Pipe Schedule:** 1.5mm to 2.5mm

**Pipe Material:** 70/30 or 90/10

**Corrosion Allowance:** N/A



# LOKRING: Shapes



# LOKRING: Typical Applications

Fire Suppression Foam

Paint Systems

Chemical Injection Systems

Chemical Vent Lines

Product loading lines

Sample Stations

Surfactant solutions

Hydraulic and Lubricating oils

Hydrocarbon Solvents

Distillates and aromatics

Production sour crude oil

Fuel Gas

Fuel Oil

Hazardous and Non-Hazardous Vent/Drain lines

Supplied Natural Gas

Gas Dehydration

Flare Headers and Laterals

Steam, condensate and drain lines

Hydrogen Sulphide

Clean Hydrogen

Boiler feed and blow down water

Steam Tracing

Breathing Air

Compressed air – process, instrument, utility

Air Dryers

Water - cooling, utility, fire, potable

Fire Deluge

Vacuum lines

Viscous Organics

Hot resins

Waste solvents

Heat transfer services

Glycol vent/drain lines

Ethylene

Oxygen

Nitrogen

Sulfuric Acid

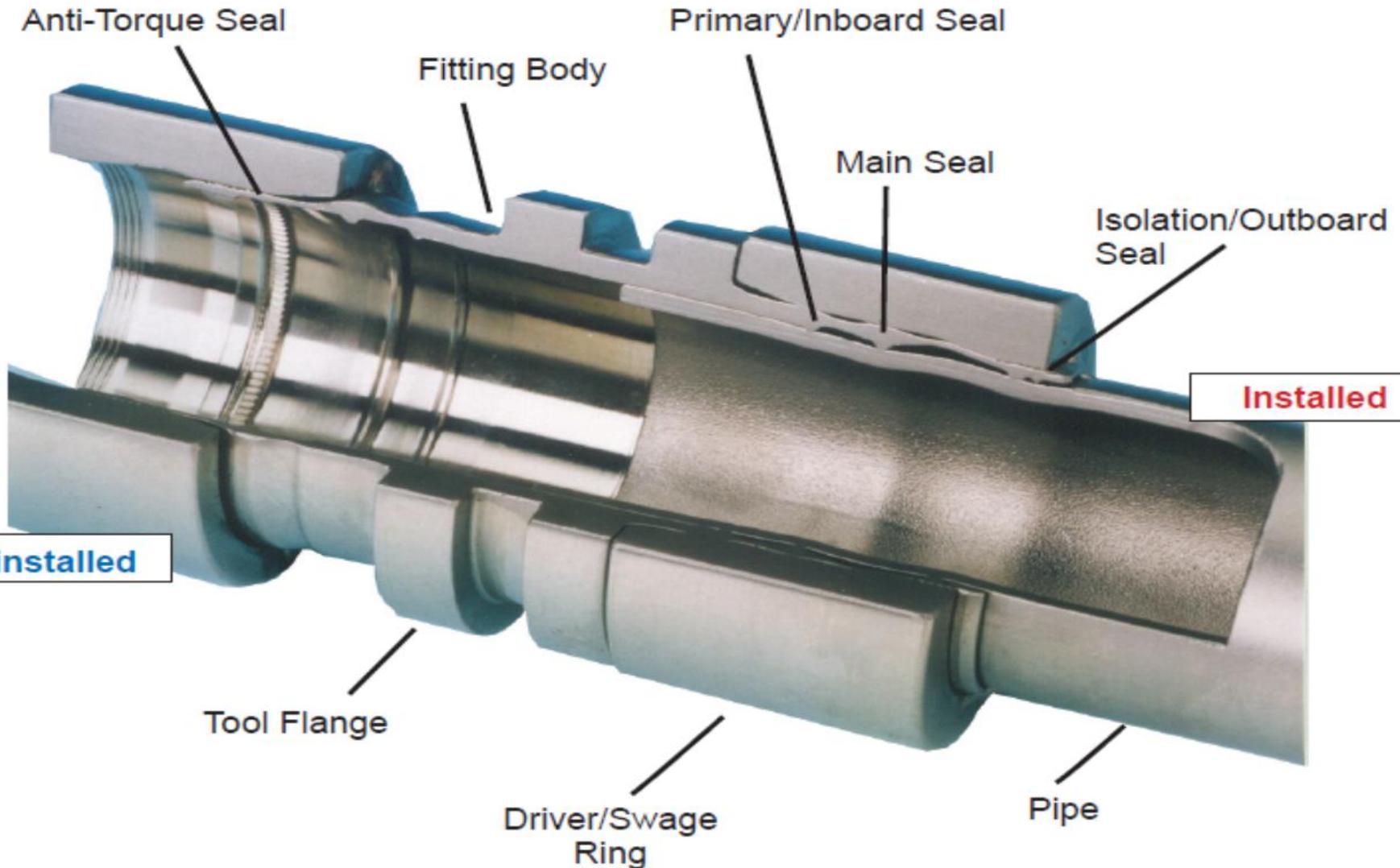
Caustic

Sour Caustic

Amines

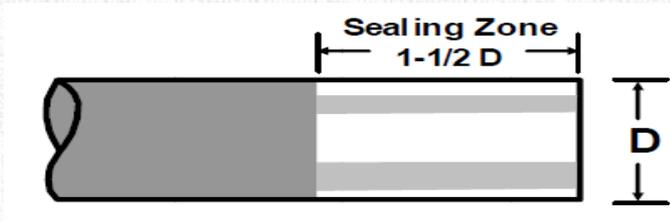


# Elastic Strain Preload®



# LOKRING: Demo

Install Video: <https://youtu.be/nKAypKy9xeg>



## STEP 1: PIPE SURFACE PREPARATION

- 1.1: CLEAN 1 ½ X OD USING EMERY PAPER
- 1.2: VISUALLY INSPECT FOR PITS/SCRATCHES
- 1.3: USE FINGERNAIL TO CHECK

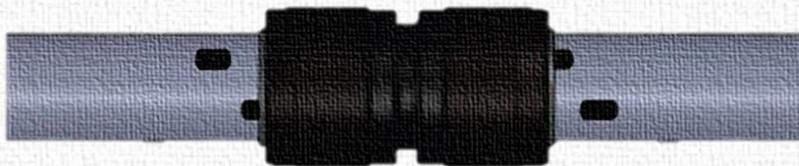


## STEP 2: MULTI-PURPOSE GAUGE CHECKS

- 2.1: GO/NO-GO GAUGE
- 2.2: INSERT PIPE TO GAUGE
- 2.3: CHECK FOR SQUARE OF CUT

## APPLY INSTALL AND INSPECT MARKS

## STEP 3: POST INSTALL VISUAL CHECKS



- 3.1: 1 AND ½ MARKS VISIBLE
- 3.2: DRIVE RING TIGHT AGAINST BODY
- 3.3: BODY LIP PROTRUDING



# LOKRING: ASME Code



The American Society of  
Mechanical Engineers

*Reprinted From*  
PVP-Vol. 210-1, Codes and Standards and Applications for  
Design and Analysis of Pressure Vessel and Piping Components  
Editors: R. F. Sammataro, G. A. Antaki,  
K. R. Rao, and J. E. Staffiera  
Book No. H00636 - 1991

## QUALIFICATION OF NON-STANDARD PIPING PRODUCT FORM FOR ASME CODE FOR PRESSURE PIPING, B31 APPLICATIONS

M. Biersteker, C. Dietemann, and S. Sareshwala  
LOKRING Corporation  
Foster City, California

R. W. Haupt  
Pressure Piping Engineering Associates, Incorporated  
Foster City, California

- The ASME B31 Code permits the use of Lokring products - classified as “Unlisted Components” - for use in pressure piping systems. 304.7.2 Unlisted Components:
- (A) EXTENSIVE, SUCCESSFUL SERVICE EXPERIENCE UNDER COMPARABLE CONDITIONS WITH SIMILARLY PROPORTIONED COMPONENTS OF THE SAME OR LIKE MATERIAL.
- (B) EXPERIMENTAL STRESS ANALYSIS, SUCH AS DESCRIBED IN THE BPV CODE, SECTION VIII, DIVISION 2, ANNEX 5.F.
- (C) PROOF TEST IN ACCORDANCE WITH ASME B16.9, MSS SP-97, OR SECTION VIII, DIVISION 1, UG-101.



# LOKRING: ASME Code

• (B) EXPERIMENTAL STRESS ANALYSIS, SUCH AS DESCRIBED IN THE BPV CODE, SECTION VIII, DIVISION 2, ANNEX 5.F.



Test Specimen No.	Pipe Size	Pipe OD Nominal	Pipe Material	Sched	Pipe Wall Nominal	Pipe Test Stress (based on Projected Load and Z) = Fact I / Z	Test cycles	SIF (based on Z) = 245000 / Sp test N 0.2		
10-009-02-		inches			inches	psi	cyc.	-		
-01	3" NPS	3.500	ASTM A333 Grade 6	40	0.216	37,539	59,433	0.72		
-02						42,175	10,764	0.91		
-03						38,779	16,178	0.91		
-04				44,692	13,414	0.82				
-05				80	0.300	40,840	14,680	0.88		
-06						41,246	14,281	0.88		
-07			40,141			13,263	0.91			
-08			ASTM A106B/A53B/API 5L B	40	0.216	38,891	17,874	0.89		
-09						38,975	30,675	0.80		
-10						42,559	9,470	0.92		
-11						80	0.300	38,095	13,015	0.97
-12								41,587	17,873	0.83

Flex Fatigue Video Link

<https://www.youtube.com/watch?v=toWoAa2HYqU>



# LOKRING: ASME Code

- (C) PROOF TEST IN ACCORDANCE WITH ASME B16.9, MSS SP-97, OR SECTION VIII, DIVISION 1, UG-101.



Burst Test Video Link

<https://www.youtube.com/watch?v=xwq4wVTAjJE>

Test Specimen No.	Pipe Size and Schedule	Pipe OD Nominal		Pipe Material	Burst Pressure		B31.3 Pressure Rating (uncorrod) = c B Sa b / f Sb UTS act	
		inches	mm		psi	Bar	psi	Bar
10-011-01-xx	-			-				
-01	4" NPS SCHED 40	4.5	114	ASTM A333 Grade 1/6	7,500	517.1	2,220	153.1
-02	4" NPS SCHED 40				7,500	517.1	2,220	153.1
-03	4" NPS SCHED 40				7,500	517.1	2,220	153.1
-04	4" NPS SCHED 80				11,500	792.9	3,410	235.1
-05	4" NPS SCHED 80				11,500	792.9	3,410	235.1
-06	4" NPS SCHED 80				11,500	792.9	3,410	235.1
-07	4" NPS SCHED 40			ASTM A53, A106, & API5L GRAD E B, X42	8,000	551.6	2,370	163.4
-08	4" NPS SCHED 40				8,000	551.6	2,370	163.4
-09	4" NPS SCHED 40				9,000	620.5	2,550	175.8
-10	4" NPS SCHED 80				10,000	689.5	2,830	195.1
-11	4" NPS SCHED 80				9,000	620.5	2,550	175.8
-12	4" NPS SCHED 80				10,500	723.9	2,970	204.8

# LOKRING: NACE Suitability

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ConocoPhillips

## DRILLING & PRODUCTION TECHNOLOGY REPORT DISTRIBUTION LIST

**TITLE:** Sour Service Testing of Assembled Lokring® Mechanical Connections

**AUTHOR(S):** Hernan E. Rincon and Dale R. McIntyre, PAT, Bartlesville

**BASIC DISTRIBUTION FOR REPORT No. 24-2007-161706**

- COP Alaska requested sour service testing of Lokring mechanical connections for use on North Slope.
- Exposure testing conducted with contractor laboratory (Honeywell).
- Metallurgical analysis post exposure testing performed in the Materials Engineering Laboratory at Bartlesville Technology Centre.



# LOKRING: NACE Suitability

## Testing Description

Testing consisted of internal exposure testing of the assemblies using NACE TM0177 Solution A and for a maximum duration of 30 days or until leakage occurs. NACE TM0177 solution A is 5% NaCl acidified with 0.5% of glacial acetic acid. Other conditions are as follows:

- a.- TW Lokrings (Carbon Steel) tests conducted at 1 atm of H<sub>2</sub>S and room temperature (76°F) to assess Sulfide Stress Cracking (SSC)
- b.- Stainless Steel Lokrings (316 SS) tests conducted 1 atm of H<sub>2</sub>S and 160°F to assess Chloride SCC as well as SSC.

- The temperature limit for use of 316 SS according to COP standards in chloride containing environment is 60degC which is also the limit considered by NACE MR)175/ISO15156.
- After sour service test exposure, coupling assemblies were subjected to wet fluorescent magnetic particles inspection method (WFMT).



# LOKRING: NACE Suitability

## SUMMARY

No evidence of cracking was observed on assembled Lokring™ mechanical connections internally exposed to NACE TM0177 Method A sour test solutions for 30 days. The carbon steel Lokring connections tested at 76°F showed corrosion pitting but no sulfide stress cracking. The 316L stainless steel Lokring connections did not show pitting or stress corrosion cracking after testing at 160°F. Also, no evidence of cracking was found on the carbon steel piping material tested at both temperatures.

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5. [REDACTED] the Lokring mechanical connections should be suitable for use in North Slope sour service applications within the H<sub>2</sub>S partial pressure and temperature limitations listed in NACE MR0175/ISO15156 and those derived from this work.
- For 316L SS Max temperature of 140°F and 15 psia of H<sub>2</sub>S.
  - For Carbon Steel L80 any temperature is allowed with a more restrictive partial pressure of H<sub>2</sub>S of 15 psia. derived from the conditions tested in this report.



# CASE STUDY 1: ConocoPhillips

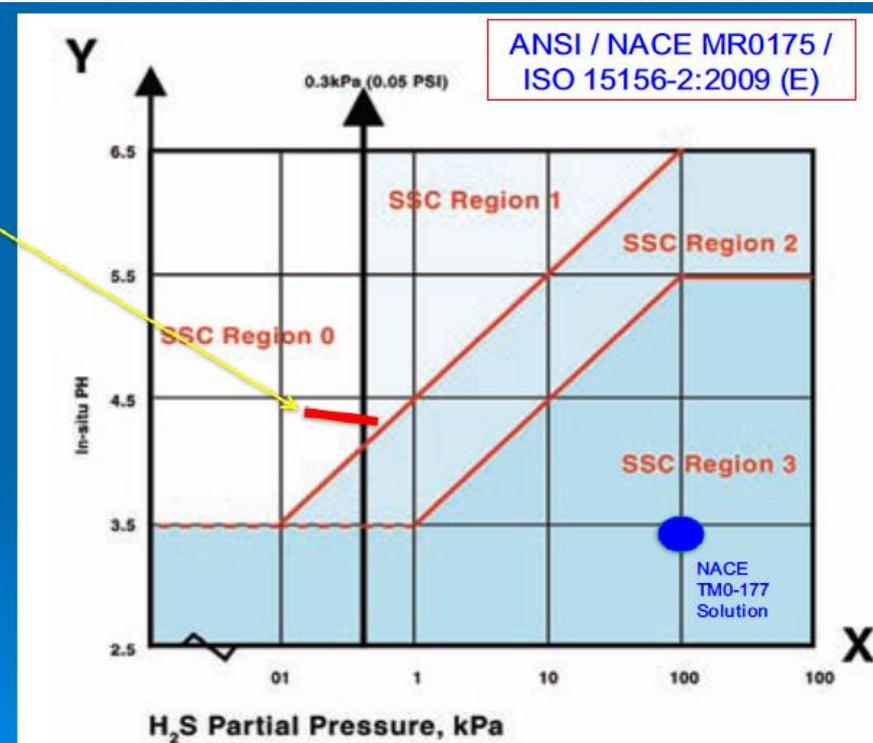
## ConocoPhillips Alaska.

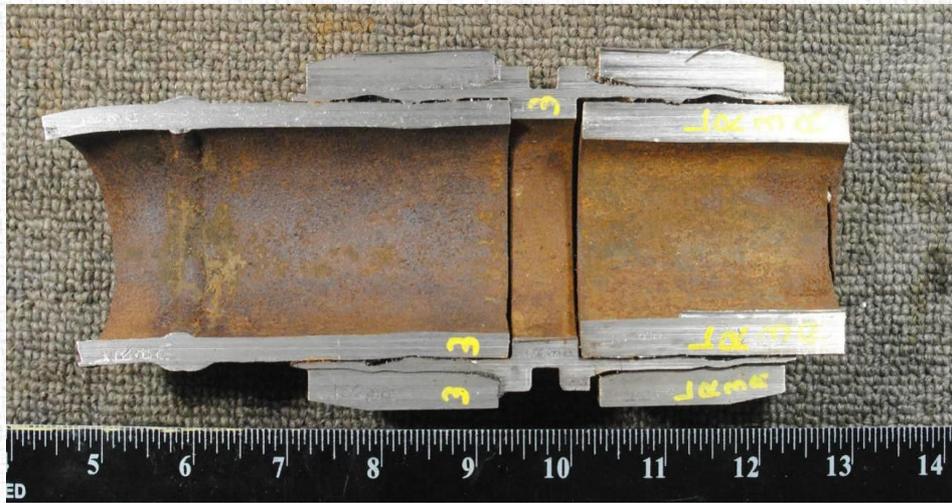
- Conoco removed corroded piping during a renovation, which contained several Lokring LTCS-333 NPS 2" fittings.
- Couplings were in service for 4-6 years.
- The pipe was in service longer than the fittings, nevertheless the pipe was removed due to corrosion.
- The fittings were used in a Drain Service in Drillsite 3G manifold modules at Kuparuk. "These lines are connected to Production Crude, Water Injection and Lift Gas - So they get a little of everything in alternating batches. This service is the worst there is."

Estimated System Conditions- LTCS fittings exposed to at Drillsite 3G. The range was most likely Region 0 with possible excursions when fittings were exposed to lift gas or possible "stimulation" spent acid into Region 1. TBC

Note that most upstream & downstream conditions will be in the Regions 0 & 1.

Region 3 conditions would most likely only occur in downhole locations





A metallurgy analysis was performed on Lokring fittings...

**Visual Inspection:** Corrosion products were observed on the metal to metal inboard seal.

**Material Chemical Analysis:** exposed that the Collar and Lokring body meet the requirements of specification AISI/SAE 4130 and the pipe meet the requirements of specification AISI/SAE 1513.

**Wet Fluorescent Magnetic Particle (WFMP) Inspection:** No evidence of cracking or other relevant indications were found in any component examined.

**Shallow pitting (approx. 4 mils depth) filled with corrosion products were observed on the internal surface of the inboard seal of the Lokring. The allowable corrosion rate for this system was 6mils per year!**

4 mils = 0.1016mm

6 mils = 0.1524mm



# CASE STUDY 2: Sabic UK

## Background

SABIC UK have been using Lokring fittings since before 2007.

SABIC TAR is the biggest petrochemical shutdown in Europe, occurs every 6 years. Over 1,000,000 man hours.



## Challenge

Shutdown manager (Neil Hutcheson, now retired) approached Lokring Northern UK.

Due to large volume of piping scopes small bore welding was creeping into the critical path of the shutdown.

One of the most common causes for delayed shutdowns is weld failures on small bore piping.



## Requirement

- Neil wanted to utilise Lokring connectors to replace 3,000 site welds.
- Fittings were used on: ~20 steam distribution stations, pilot flare lines (250 fittings) and a couple of other utility systems including instrument air and nitrogen.
- Fittings were a mixture of sizes and shapes including couplings, reducers and flanges in both Carbon Steel and Stainless Steel.

## Outcome

- Lokring trained 40 of Sabic personnel and contractors who's only job for the shutdown was Lokring installations. They were split into two teams and installed all 3,000 fittings in 4 weeks.
- ZERO rework from 3,000 connections!!
- TAR Priority: Safety, Quality, Duration, Cost – Lokring marginally improved in all areas!



**'We are unable to quantify the total savings...**

**All 3,000 Lokring fittings were installed for less than what the NDT cost OR the habitat cost  
would have been alone...**

**not to mention productivity or scaffolding!'**



