Innovative ‘Cold Weld’ Solution for Pipe Repairs and Construction

Jake Rowley – Regional Technical Manager
jrowley@lokring.com
LOKRING: Our Clients
## LOKRING: Materials

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Size Range</th>
<th>Schedule</th>
<th>Pipe Material</th>
<th>Corrosion Allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro Alloysed Steel (MAS-3000)</td>
<td>¼” to 4”</td>
<td>40-160</td>
<td>A106 B, A53 B, API 5L, A333 Gr 6</td>
<td>1.6mm</td>
</tr>
<tr>
<td>Low Temp Carbon Steel (LTCS)</td>
<td>¼” to 4”</td>
<td>40-XXS</td>
<td>A106 B, A53 B, API 5L, A333 Gr 6</td>
<td>3.2mm</td>
</tr>
<tr>
<td>Stainless Steel (316/316L) (SS40)</td>
<td>¼” to 3”</td>
<td>10-80</td>
<td>A106 B, A53 B, API 5L, A333 Gr 6, 316/316L, 304</td>
<td>N/A</td>
</tr>
<tr>
<td>Copper Nickle (CuNi)</td>
<td>M12 – M57</td>
<td>1.5mm to 2.5mm</td>
<td>70/30 or 90/10</td>
<td>N/A</td>
</tr>
</tbody>
</table>
LOKRING: Shapes
LOKRING: Typical Applications

Fire Suppression Foam
Paint Systems
Chemical Injection Systems
Chemical Vent Lines
Product loading limes
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
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
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.

Flex Fatigue Video Link
https://www.youtube.com/watch?v=toWoAa2HYqU

<table>
<thead>
<tr>
<th>Test Specimen No.</th>
<th>Pipe Size</th>
<th>Pipe OD Nominal</th>
<th>Pipe Material</th>
<th>Sched</th>
<th>Pipe Wall Nominal</th>
<th>Pipe Test Stress (based on Projected Load and Z) = Fact I / Z</th>
<th>Test cycles</th>
<th>SIF (based on Z) = 245000 / Sp test N 0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-009-02-01</td>
<td>inches</td>
<td>inches</td>
<td>ASTM A333 Grade 6</td>
<td>40</td>
<td>0.216</td>
<td>37,530</td>
<td>59,433</td>
<td>0.72</td>
</tr>
<tr>
<td>-02</td>
<td></td>
<td></td>
<td></td>
<td>42,175</td>
<td>10,764</td>
<td>36,779</td>
<td>16,178</td>
<td>0.91</td>
</tr>
<tr>
<td>-03</td>
<td></td>
<td></td>
<td></td>
<td>44,692</td>
<td>13,414</td>
<td>40,840</td>
<td>14,680</td>
<td>0.88</td>
</tr>
<tr>
<td>-04</td>
<td></td>
<td></td>
<td></td>
<td>41,246</td>
<td>14,281</td>
<td>40,141</td>
<td>13,263</td>
<td>0.88</td>
</tr>
<tr>
<td>-05</td>
<td></td>
<td></td>
<td></td>
<td>38,891</td>
<td>17,874</td>
<td>38,975</td>
<td>30,675</td>
<td>0.80</td>
</tr>
<tr>
<td>-06</td>
<td></td>
<td></td>
<td></td>
<td>42,559</td>
<td>9,470</td>
<td>42,559</td>
<td>9,470</td>
<td>0.92</td>
</tr>
<tr>
<td>-07</td>
<td></td>
<td></td>
<td></td>
<td>38,095</td>
<td>13,015</td>
<td>41,587</td>
<td>17,873</td>
<td>0.83</td>
</tr>
<tr>
<td>-08</td>
<td>3&quot; NPS</td>
<td>3.500</td>
<td>ASTM A106B/A53B/API 5L B</td>
<td>40</td>
<td>0.216</td>
<td>38,891</td>
<td>17,874</td>
<td>0.89</td>
</tr>
<tr>
<td>-09</td>
<td></td>
<td></td>
<td></td>
<td>38,975</td>
<td>30,675</td>
<td>42,559</td>
<td>9,470</td>
<td>0.92</td>
</tr>
<tr>
<td>-10</td>
<td></td>
<td></td>
<td></td>
<td>38,095</td>
<td>13,015</td>
<td>41,587</td>
<td>17,873</td>
<td>0.83</td>
</tr>
<tr>
<td>-11</td>
<td></td>
<td></td>
<td></td>
<td>38,891</td>
<td>17,874</td>
<td>38,975</td>
<td>30,675</td>
<td>0.80</td>
</tr>
<tr>
<td>-12</td>
<td></td>
<td></td>
<td></td>
<td>42,559</td>
<td>9,470</td>
<td>42,559</td>
<td>9,470</td>
<td>0.92</td>
</tr>
<tr>
<td>Test Specimen No.</td>
<td>Pipe Size and Schedule</td>
<td>OD Nominal (inches)</td>
<td>Pipe Material</td>
<td>Burst Pressure (psi)</td>
<td>Pressure Rating (Bar)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------</td>
<td>---------------------</td>
<td>---------------</td>
<td>---------------------</td>
<td>----------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-011-01-xx</td>
<td>4&quot; NPS SCHED 40</td>
<td>4.5</td>
<td>ASTM A333 Grade 1/6</td>
<td>7,500</td>
<td>517.1 psi 2,220 Bar 153.1 psi 163.4 Bar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-02</td>
<td></td>
<td></td>
<td></td>
<td>7,500</td>
<td>517.1 psi 2,220 Bar 153.1 psi 163.4 Bar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-03</td>
<td></td>
<td></td>
<td></td>
<td>7,500</td>
<td>517.1 psi 2,220 Bar 153.1 psi 163.4 Bar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-04</td>
<td>4&quot; NPS SCHED 80</td>
<td>4.5</td>
<td>ASTM A53, A106, &amp; API5L GRAD E B, X42</td>
<td>10,000</td>
<td>689.5 psi 2,830 Bar 195.1 psi 204.8 Bar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-05</td>
<td></td>
<td></td>
<td></td>
<td>9,000</td>
<td>620.5 psi 2,550 Bar 175.8 psi 195.1 Bar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-06</td>
<td></td>
<td></td>
<td></td>
<td>9,000</td>
<td>620.5 psi 2,550 Bar 175.8 psi 195.1 Bar</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Burst Test Video Link
https://www.youtube.com/watch?v=xwq4wVTAjjE
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.
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).
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.

5. The Lokring mechanical connections should be suitable for use in North Slope sour service applications within the H₂S 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 H₂S.
   • For Carbon Steel L80 any temperature is allowed with a more restrictive partial pressure of H₂S 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.”
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!’