



# Making Pipelines Last



## WELDED JOINT SYSTEM FOR THIN LININGS

Comparison of LPS Technology vs. Robot for Internal Joint Coating

Pipelines transporting corrosive liquids require an internal lining to prevent corrosion that would shorten the life of the pipeline.

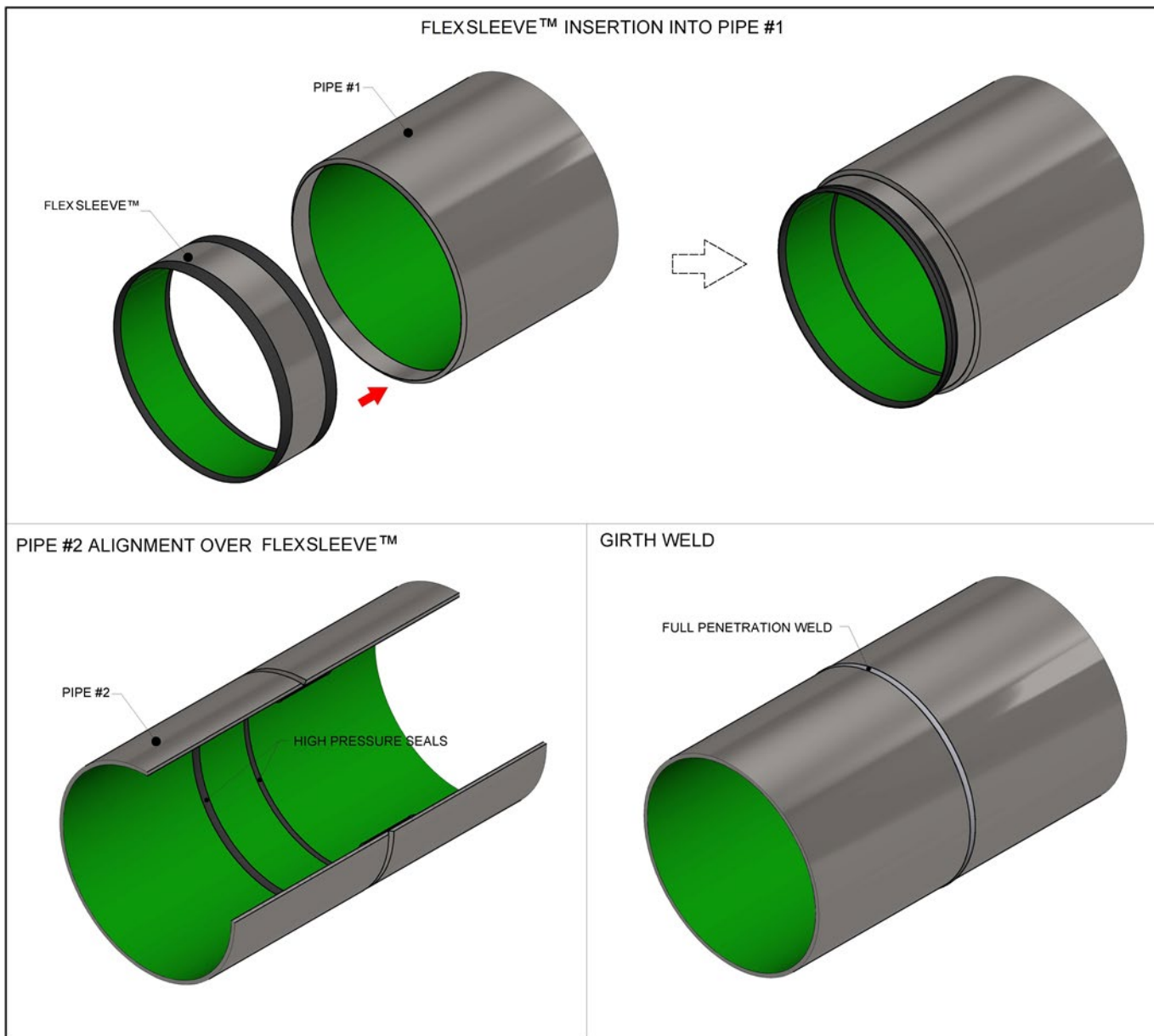
Long distance and high-pressure pipelines generally require welded joints.

**The question is: how to protect the interior steel of the weld zone from corrosion when the weld arc would destroy a corrosion-resistant polymer at this location.**

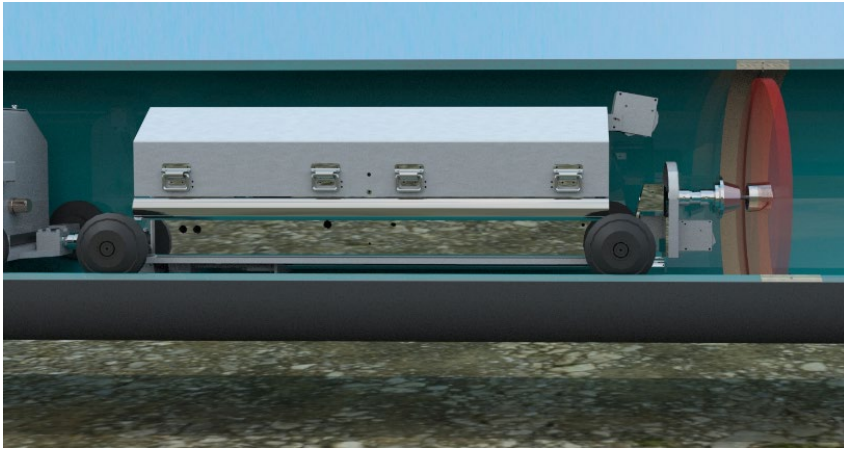


# The LPS Solution

FlexSleeves inserted into pipe ends protect the weld zone from corrosion



**A common solution for pipelines with internal linings has been to use a robot to paint the joints after welding. The idea may sound good, but in reality months of delays, huge robot-caused cost over-runs, and quality issues due to unpredictable environmental and weld conditions are the norm.**

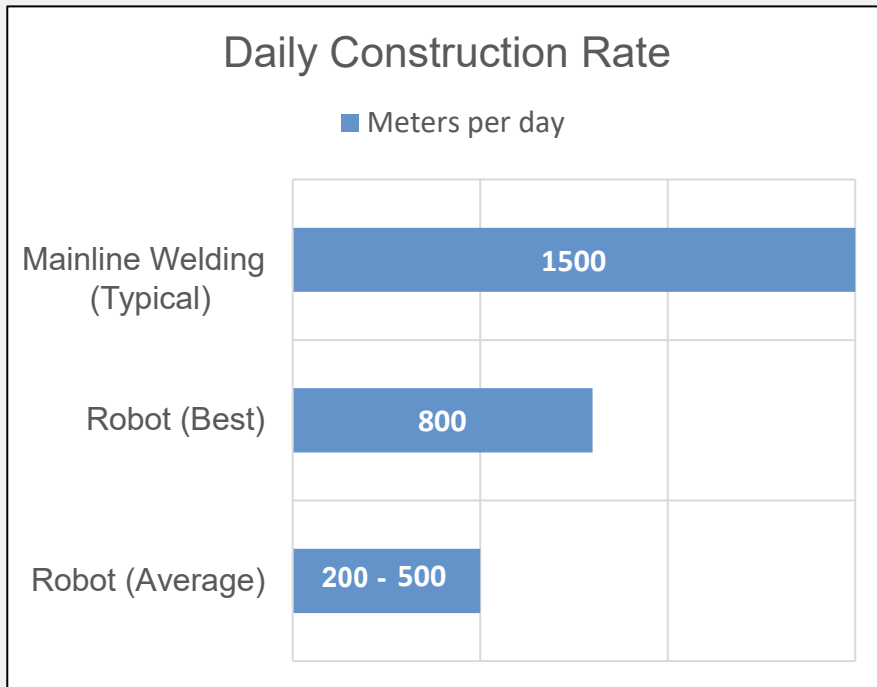


Robots crawl through the pipeline after mainline welding crews. Each joint must be grit blasted, cleaned, painted, and tested for proper cure and continuity. With LPS' system the internal corrosion protection is complete when the weld is complete.



Using a robot to paint the welds leaves crews spread over 30 – 60 km waiting for the robots to finish their work. LPS' system allows for standard pipeline construction with the pipe lowered in into the ditch and buried just after welding.

LPS received feedback from Contractors and Engineers on four projects that used the robot to coat internal joints in Chile: BHP Billiton EWS, BHP Billiton Spence, BHP Billiton Escondida & AMSA El Mauro Tailings Return Water. In all of them the robot was severely behind schedule.



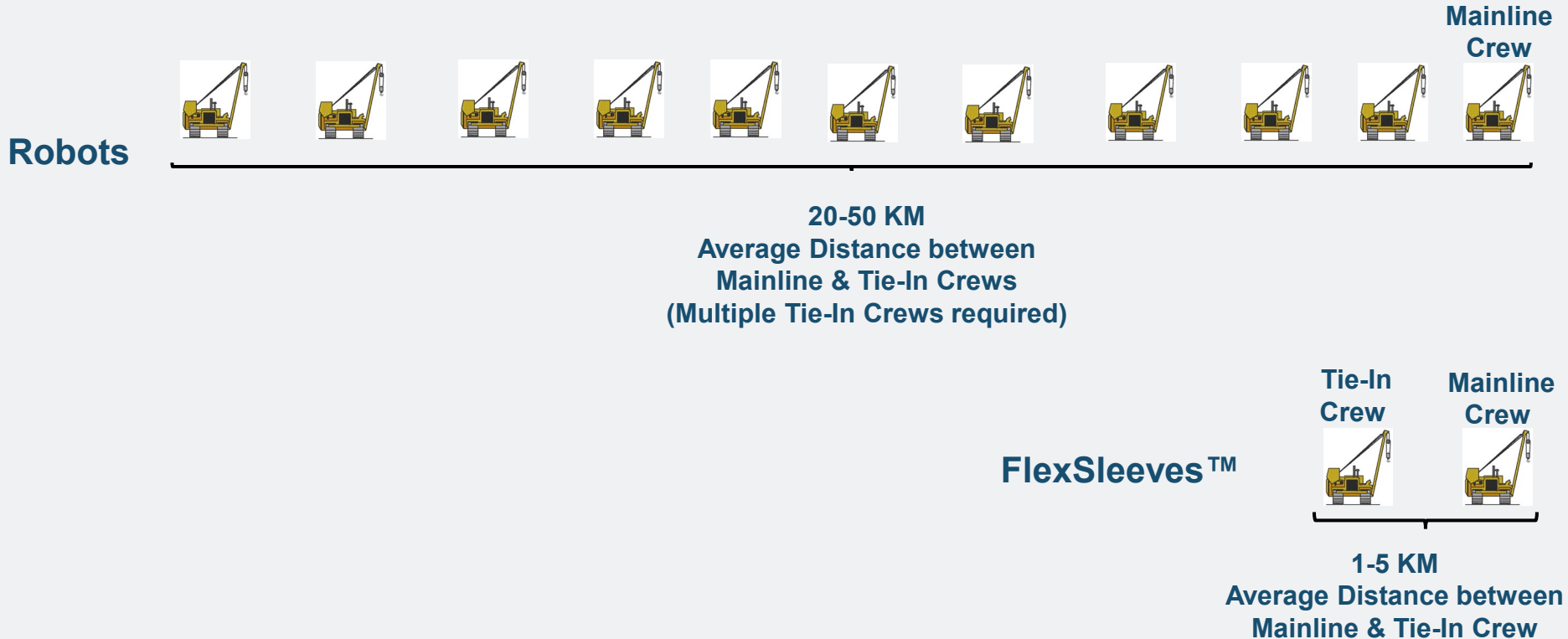
The productivity of the robot on the right of way and at double jointing yards is slow and unpredictable. The data used in this chart was derived from Contractor feedback on projects constructed in Chile.



# Construction Complexity: Tie-Ins

Tie-in crews follow behind the robots, which proceed at a slow, unpredictable rate. A typical Project involves the use of several robot crews, each requiring Contractor equipment support with side-booms, transportation, and generators. Tie-in crews are usually far behind mainline crews and support logistics are required to be strung out over vast distances. The complexity of construction is significantly increased, leading to increased cost and delays.

When FlexSleeves are used, the joint is complete as soon as it passes NDE. Tie-in crews are close behind the mainline crew like normal pipeline construction projects.



Topic	Robot	FlexSleeve™ & Joint Lock Rings™
<b>Steel Temperature</b>	Epoxy protective materials are generally not applied to steel above 40 C or below 0 C. Cold temperatures significantly lengthen cure time. Hot steel temperatures can cause epoxy to sag or bubble.	Protective materials are applied in controlled shop setting, completely eliminating all quality problems associated with field-applied coatings.
<b>Humidity</b>	Steel temperature must be above dew point when liquid epoxy is applied.	Protective materials are applied in controlled shop setting, completely eliminating all quality problems associated with field-applied coatings.
<b>Adhesion to Pipe Lining</b>	Edge of existing pipe lining must be properly abraded. Fusion bonded epoxy (FBE) is difficult to bond to. Risk exists that abrasive blasting removes excessive amount of parent pipe lining at edge where robot-applied epoxy does not cover it.	Bore Seal seals against parent pipe lining and eliminates need to tie into factory-applied pipe lining.
<b>Weld Penetration</b>	Special requirements for extra-smooth weld penetration required. High risk of epoxy pinhole leaks on jagged weld surfaces. Lining pinhole formation on welds - AFTER having passed holiday test - are common.	Joints can be welded using most standard weld methods. Weld penetration irrelevant with FlexSleeves & Joint Lock Rings serving as backing ring.
<b>Pipe lining protective materials</b>	Fusion bonded epoxy (AWWA C-213) and polyurethane (AWWA C-222) are widely used to line pipe interiors, yet robot faces massive quality challenges when applying these materials in field.	FlexSleeves & Joint Lock Rings can be used with any internal pipe lining. Sleeve & ring linings meet or exceed requirements of parent pipe lining.

# Schedule & Cost Comparison

Topic	Robot	FlexSleeve™ & Joint Lock Rings™
<b>Schedule</b>	Robot cannot keep up with mainline weld crews. Each joint is grit blasted, cleaned, painted, and holiday tested after NDE has been performed on the weld.	Installation takes 2 - 3 minutes per joint, is done ahead of mainline crew, and can be scaled to keep up with mainline crew or double jointing operation.
<b>Schedule</b>	Contractor tie-in crews, equipment, and other resources remain behind with robots. Project completion must wait for robots & tie-in crews to finish, often increasing project duration by months.	No subsequent steps required after welding. After NDE and external joint coating the pipe can be buried just like normal pipeline construction.
<b>Schedule: Tie-ins</b>	Most long distance pipelines have a tie-in every ~ 1km. Robots require tie-ins every ~500m and must travel long distance to perform all steps on tie-in welds, generally taking an entire shift to complete one tie-in.	Permits normal frequency of tie-ins. Joint Lock Rings allow for faster tie-ins with joint interior protected as soon as weld is complete.
<b>Schedule: Double-jointing</b>	Robot cannot keep up with double jointing operation.	FlexSleeve installation can keep up with double-joint welding rate.
<b>Cost</b>	Total cost is far higher when including schedule delays, lengthened mobilization of tie-in crews & equipment, and robot support labor/equipment.	Far less total cost.



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<b>Automatic welding</b>	Many automatic weld methods include an internal weld bead, which is possible with robot lining joints after welding.	Automatic weld methods that weld only from OD must be used. LPS provides specialized internal lineup clamp for use with automatic welding.
<b>NDE of welds</b>	Standard RT & UT methods. Robot must wait until after weld passes NDE in order to line internal weld joint.	Standard RT & UT methods. NDE technician takes into account the geometry of sleeves or rings under the weld when interpreting results.
<b>Weld repairs</b>	Weld repairs: standard weld repair methods.	Standard weld repair methods, with care taken to not grind past ring OD when grinding out weld defects.
<b>Pipe alignment &amp; welding</b>	Mainline welding crew is able to align and weld pipe how they are accustomed to doing so with bare pipe.	Pipe alignment may take 1-2 minutes longer. Internal line-up clamps modified for use with LPS technology will align pipe at standard pace. Standard pipeline weld procedures and welding pace.

# Projects Highlighting Robot Risk

## BHP Billiton Escondida Mine EWS Project, Chile (2014 – 2017)

- 2 ea. 42" x 170km desal water lines. EPC: Bechtel.
- Robot Cost (17 robots): \$29m USD  
Comparative Cost for LPS Technology: ~\$35m USD
- Construction pace: 1,400 meters/day  
Robot pace: 200 – 800 meters / day
- Bechtel's **total cost incl. schedule delays**, support personnel, support equipment & hand-coating some joints: **\$110m USD**
- **Result: Bechtel pulled performance bond of robot contractor. Due to lack of confidence in schedule and quality that robot offers, Bechtel is now constructing 2 desal water lines in Chile WITHOUT an internal lining. Pipeline failure due to corrosion is all but assured before mine life is over, so two or even three pipelines would need to be constructed during mine life.**

## BHP Billiton Spence Growth Project, Chile (2019 – 2020)

- 36" x 154km desal water line. Contractor: Saipem.
- **Mainline weld crew was at least 40 km ahead of robot.**
- **Chinese robots regularly malfunctioned & thixotropic issues with paint material related to steel temperatures caused the paint to slide down the pipe wall. The result was excess paint thickness on pipe bottom and too thin on pipe sides.**

## AMSA Los Pelambres Mine El Mauro Tailings Project, Chile (~2007 – 2009)

- 32" dia. x 60 km tailings return water line. Design engineer: Ausenco
- **Robot extremely far behind schedule, with comments from Ausenco's Chile office stating that it was unlikely they would recommend it again for a project.**

- FlexSleeves have a thickness of approximately 7 mm and restrict the diameter approximately 14 mm. Joint Lock Rings have a thickness of approximately 14mm and restrict the diameter approximately 28 mm.
- Head loss is generally between 1 – 2.5% dependent on pipe diameter and pipe lengths between joints.
- Pigs easily pass through diameter restriction at joints with sleeves and can read steel thickness behind FlexSleeves & Joint Lock Rings.
- Gauge pig data is not interfered with by diameter restriction at rings.
- FlexSleeves & Joint Lock Rings are welded to the pipe wall and do not move during pigging.



# Contact Information

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## Welded Joint System for Thin Linings

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