

THE USE OF
IN-LINE INSTRUMENTED TOOLS
IN
Zap-Lok® Connections

Prepared For:

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Zap-Lok® Connection

1.0 Executive Summary

This test was conducted to confirm that pipelines which are constructed using the Zap-Lok® process can be pigged successfully with High-Resolution Instrumented (ILI) Survey Tools.

Instrumented pigging vendors and industry experts have made favorable comments regarding the ability to run instrumented tools through Zap-Lok® connections.

The results of this test and interviews with ILI vendors and experts leads to the conclusion that the Zap-Lok® connection, as shown in Figure 1, is both piggable and inspectable.

An instrumented pig will have reduced sensitivity to anomalies on the outside surface of the connection similar to that experienced on the outside surface of a repair sleeve.

Significant additional information can be gained about anomalies and other areas of interest by increasing the resolution of the ILI data in the area of the connection.

The connection also lends itself to the use of Ultrasonic, Deformation, TFI and Combination tools. The connection can also be examined using Direct Assessment techniques.

Use of In-Line Instrumented Tools in pipelines joined by the Zap-Lok® process is recommended.

Zap-Lok® Connection

2.0 Background

The patented Zap-Lok® connection has been in continuous use for over 30 years to join lengths of line pipe in the field. The Zap-Lok® process is widely used as a cost effective and high quality alternative to field girth welding. The process preserves the integrity of internal coating throughout each connection. High production rates can be attained during field joining, even in inclement weather. The connection is also frequently used on offshore lay barges. It has been shown to provide a safe, leak tight and strong connection. Thousands of Zap-Lok® connections are in service.

A drawing of the typical Zap-Lok® connection is attached as Figure 1.

From time to time the question has been raised as to whether or not instrumented survey tools (ILI) could be run successfully in pipelines which have been constructed using the Zap-Lok® connection process. A test was carried out and this report was commissioned to describe the test and provide a final answer to the question of pigability.

In preparation for the test the Zap-Lok® connection was discussed, and drawings of the connection were reviewed, with the instrumented pigging vendors and a number of ILI industry experts. It was determined that the following pigging vendors have successfully run instrumented pigs in pipelines with Zap-Lok® connections:

- BHI PMG (formerly Western Atlas Corrosion Services)
- BJ Pipeline Inspection Services
- Tuboscope Pipeline Services NOV
- GE/PII (formerly PII North America)

In addition the following pigging vendors have provided an opinion on the feasibility of running pipelines with Zap-Lok® connections:

- H. Rosen Engineering
- Magpie Systems

Of those ILI vendor companies and industry experts having actual experience with the connection, none reported any pigging problems attributable to the connection. All have expressed confidence that instrumented pigs can be successfully run in pipelines joined by the Zap-Lok® connection process.

Zap-Lok® Connection

3.0 Test Methodology

3.1 Test Section

A test section was fabricated by Zap-Lok® at its facility located at 12100 West Little York Rd. in Houston, Texas. The material used was 8 inch nominal (8.625 inch OD), .188 inch wall thickness grade X52, API line pipe.

Joining was performed by the standard process in keeping with procedures as outlined in the Zap-Lok® Connection System 2001, Technical Information Manual.

The dimensions of the completed test section were as follows:

- Upstream flange to the leading edge of the first connection, 6 feet.
- Leading edge of the first connection to the leading edge of the second connection, 6 feet.
- Leading edge of the second connection to the downstream flange, 20 feet.
- Overall length of the test section, 32 feet.

The center length of line pipe in the test section was previously internally coated by Tuboscope with TK 505.

The test section was transported to the Tuboscope Pipeline Services facility at 2835 Holmes Rd. in Houston, Texas where it was flanged into their standard 8 inch pull test facility. After insertion in the pull test set-up the test section began at the flange at 91.25 feet and ended at the flange at 123.25 feet.

3.2 Anomalies

Simulated defects were introduced into the test section by Tuboscope in the form of machined pits. A ball mill was used, resulting in a pit diameter of approximately .450 to .600 inches with the exception of Pit F which is an oblique pit approximately .555 x .655 inches.

Drawings of the anomaly set are attached as Figure 2 and 3.

A description of the anomalies, locations and reference points is as follows:

Upstream Length

No anomalies present in this length of pipe.

Center Length

Pit A: - 2.5 inches upstream from the leading edge of the female pipe end, orientation 12:00, depth 23%.

Downstream Length

Pit B: - on the outside surface of the connection, 7.5 inches downstream from the leading edge of the female pipe end, orientation 12:00, depth 38%.

Pit C: - on the slope of the shoulder of the connection, 14 inches downstream from the leading edge of the female pipe end, orientation 12:00, depth 24%.

Pit D: - on the pipe body 48 inches downstream from the leading edge of the female pipe end, orientation 12:00, depth 24%.

Pit E: - on the slope of the shoulder of the connection, 11.5 inches downstream from the leading edge of the female pipe end, orientation 9:00, depth 38%.

Pit F: - on the slope of the shoulder of the connection, 11.5 inches downstream from the leading edge of the female pipe end, orientation 6:00, depth 23%.

3.3 Instrumented Pig

In-Line Inspection System Selection

A standard configuration High-Resolution “C” Tool was selected by Tuboscope for these tests based on the vendor’s normal tool selection criteria.

System Qualification Process

Pre-Inspection tool calibration and standardization procedures were performed in keeping with the vendor’s written procedures, industry best practices and guidelines as outlined in the API Standard 1163 First Edition, In-Line Inspection Systems Qualification Standards.

3.4 The Pull Test

The Zap-Lok® test section remained flanged into the 8 inch pull test set-up which is routinely employed by the vendor to test and calibrate production tools.

On April 26th 2005, pull testing was performed.

The electrically driven draw works, which is used to pull the tools, was equipped with a calibrated *Dillon Programmable Force Indicator* to measure the tension on the pull cable. This device provides a continuous measurement of the force required to pull the tool through the test pipe section. This is a calibrated tension measuring device which records at a sample rate of one tenth of a second.

In order to insure repeatability, and provide a comparison of individual pull tests, the Tuboscope Instrumented (ILI) "C" tool was pulled through the test section a total of four times.

Post-Run Validation

Post-Run tool function tests were performed in keeping with the vendor's written procedures as outlined in the API Standard 1163 First Edition, In-Line Inspection Systems Qualification Standards.

Verification

All pre-inspection tool calibration and standardization procedures, pull testing and post-run tool function tests were observed by the author and well documented by the vendor.

Zap-Lok® Connection

4.0 Pigging Results

4.1 Observations

The results from each of the four complete and separate pull tests were very similar and consistent with one another.

There were no remarkable tool or test section vibrations, or tool stoppages at the Zap-Lok® connections.

It was observed that tool travel and cable movement was the same as, or smoother than, when pulling through that portion of the pull test set-up which is joined by circumferential girth welds.

4.2 Tool Speed

Tool speed averaged between 2.8 and 3.0 mph on each of the tests.

4.3 Pull Tension

Pull cable tension load results, as measured and recorded by the calibrated *Dillon Programmable Force Indicator*, were as expected.

The force required to pull the tool through the test section containing the Zap-Lok® connections was very even and ranged between 470 and 630 LBF.

This tension load did not fluctuate noticeably when the tool was traversing the Zap-Lok® connections.

Copies of the typical force recordings are attached as Figure 4 and 5.

4.4 Tool Mechanical Damage

No tool or sensor damage was observed during these pull tests.

Zap-Lok® Connection

5.0 Inspection Results

5.1 Linaview® Data Analysis

The data was validated and compared with data from other anomalies. Data results were consistent with that which would be expected from a smooth bore mechanical joint such as the Zap-Lok® connection. The data was very symmetrical, free of shock noise and easy for an analyst to interpret. The resolution of the data was also increased for further analysis.

The complete Linaview® pull test data from the Zap-Lok® connection pull tests may be reviewed in further detail at the vendor's facility upon request.

5.2 Feature Verification and Detection Thresholds

<u>Anomaly</u>	<u>Reference Location</u>	<u>Probability of Detection</u>
Pit A:	In the parent pipe	Detected, identified, characterized and depth predicted
Pit B:	On the outside surface of the connection	Not detected
Pit C:	On the slope of the connection	Detected and identified in increased resolution data
Pit D:	In the parent pipe	Detected, identified, characterized and depth predicted
Pit E:	On the slope of the connection	Detected and identified in increased resolution data
Pit F:	On the slope of the connection	Detected and identified in increased resolution data
Anomaly G:	A previously unknown dent in the body wall of the pipe 80 inches downstream from the leading edge of the female pipe end, orientation 6:00	Detected, identified, characterized and size predicted

Pits C, E and F: are typical of anomalies where an increase in the resolution of the data is recommended in order to optimize the data analysis.

Zap-Lok® Connection

6.0 Conclusions

A pipeline that has been joined by the Zap-Lok® connection process should be considered suitable for instrumented pigging and inspection.

Given the uniform mechanical shape of the Zap-Lok® connection, a relatively predictable magnetic flux field characteristic will be present, thereby enhancing the ability to interpret ILI data. Due to the even, uniform, and consistent mechanical configuration of each Zap-Lok® connection, the resulting ILI pigging data was smooth, noise free, and predictable. The smooth tool and sensor ride through the connection is a plus in data gathering and will ease the interpretation of the resulting data.

Anomalies which are detected in the area of the connection can be differentiated from an anomaly free connection.

Just as in the case of a regular girth weld, the ability to accurately interpret the data will begin to deteriorate approximately 1½ inches upstream from the beginning of the connection and return to normal approximately 1½ inch downstream from the end of the connection.

The signals from the area of the Zap-Lok® connection should be observed just as closely as the signals from a girth weld area. Analysts will need to increase the resolution of the data from suspect areas of interest.

The data from the Zap-Lok® connection looks like two girth welds close together. The sensitivity to anomalies in this double wall thickness area will be roughly equivalent to that which would be achieved in a much heavier wall thickness.

Analysis of data at the connection area needs to be done on a comparative basis i.e. comparison to typical or normal magnetic flux patterns and the resulting signal waveforms for that connection. All anomalies in the connection area need to be manually graded although computer analysis techniques might be used to flag magnetic variations or possible anomalies in that area.

Zap-Lok® Connection

7.0 Recommendations

1. The Zap-Lok® connection as shown in Figure 1 is a piggable connection.
2. The Zap-Lok® connection can be inspected by ILI methods including MFL, Ultrasonic, Deformation, TFI and Combination technology tools.
3. The resulting ILI inspection data is suitable for use by a pipeline operating company in their Integrity Management (IM) program.
4. The Zap-Lok® connection can also be examined by Direct Assessment techniques.
5. An increase in the resolution of the MFL data at the connection is recommended where there is an indication of an anomaly or an area of possible interest near the connection.
6. Grading of the indications in areas affected by diameter change should be performed by the analyst and not computer graded.
7. Proper planning in tool selection and preparation will present an opportunity to optimize the ILI tool performance and enhance the data.
8. Instrumented pigging should be accomplished in the same direction as normal recommended pipeline flow as shown in Figure 1 (i.e. male end to female end).
9. Where there is a possibility that the direction of pipeline flow may need to be reversed from that shown in Figure 1, consideration could be given to an inverted bevel configuration as shown in Figure 6.

Zap-Lok® Connection

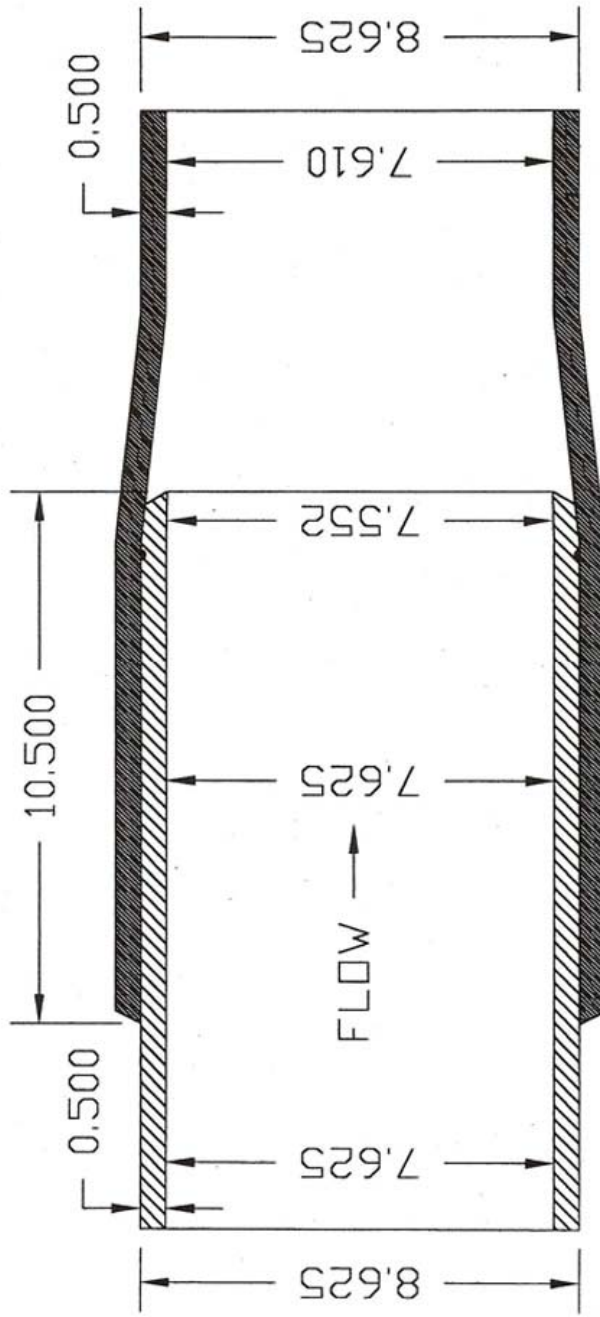
8.0 References:

1. Zap-Lok® Connection Systems 2001, Technical Information Manual, September 2001.
2. American Petroleum Institute, API Standard 1163 First Edition, In-Line Inspection Systems Qualification Standard.
3. National Association of Corrosion Engineers, NACE RP 0102 – 2002, Standard Recommended Practice, In-Line Inspections of Pipelines.
4. Southwestern Laboratories, Tension and Hydrostatic Tests of Mechanical Pipe Joints.

Zap-Lok® Connection

About the Author:

Gordon Griffiths is an independent consultant to pipeline owner companies and service providers. He routinely performs internal reviews of ILI pigging and integrity management processes. He provides input on the selection of pipeline inspection tools, project specifications and controls, validation and verification to enhance the integrity of pipeline inspections and improve the quality assurance process. Recommendations have related to pipeline preparation, pigging and operating issues, and optimizing pig configurations for improved performance in tough pipeline environments. He has been involved in technology development for Combination tools, MFL High Resolution, Deformation, INS, EMAT, SCC, Velocity Control, Hard Spot, Stress Detection, Distribution Systems, Weld Lines, Leak Detection, and Ultrasonic Weld Evaluators. He previously served worldwide as either Vice President or President of Tuboscope Vetco Pipeline Services Inc., Vetco Pipeline Services Inc., Baker Hughes Pipeline Services Inc., Combustion Engineering Vetco Pipeline Services Inc., and the AMF Tuboscope Linalog Division. He originally joined Tuboscope International Inc. in 1957 where he served as Staff Director of Quality Control and Training. He was educated at the Saskatoon Technical College, Saskatoon, Saskatchewan Canada, the University of Saskatchewan, Mechanical Engineering and Texas A&M University, Executive Development Branch. He has recently served as a committee member for the In-Line Inspection Systems Qualification Standard API 1163.



ZAP-LOCK CONNECTION 8-5/8" PIPE .500 WALL

Figure 1

8" CTOOL THRU. .188WT WITH ZAPLOC PIPE

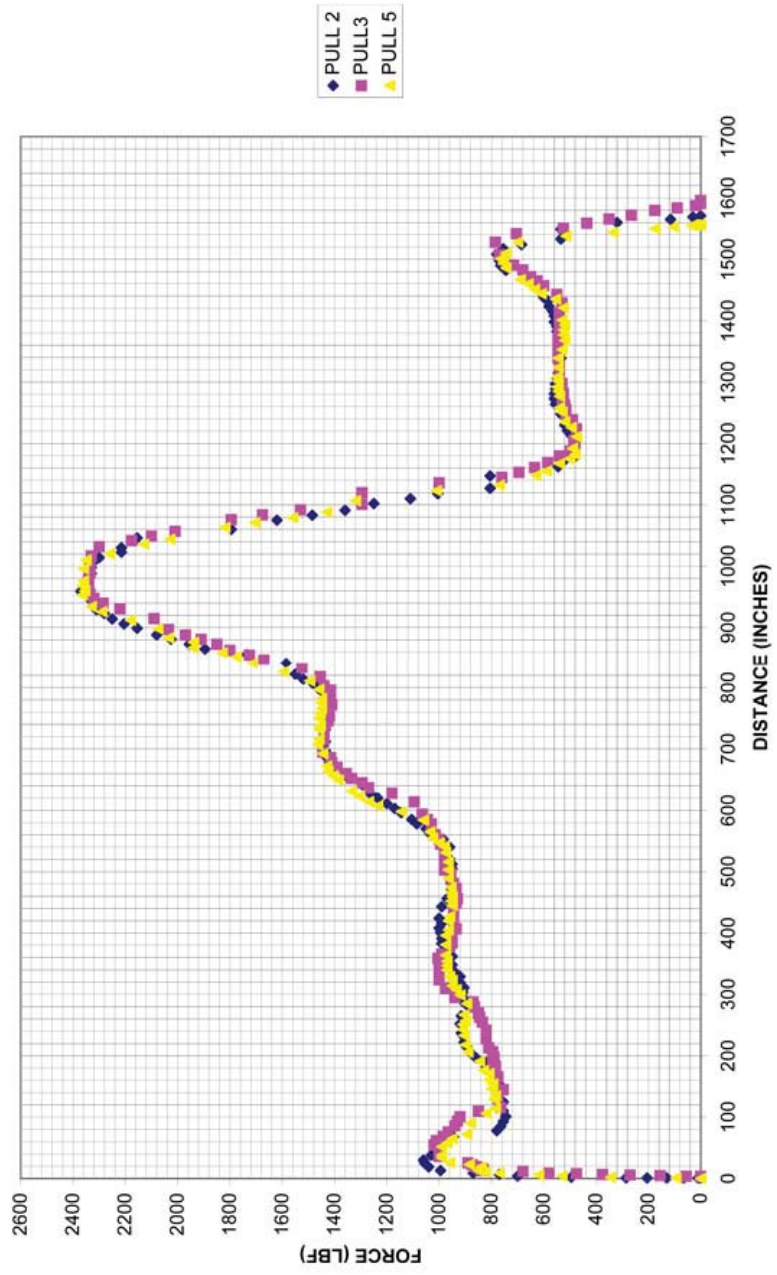


Figure 4

8" C TOOL THRU .188 WT ZAP-LOK PIPE

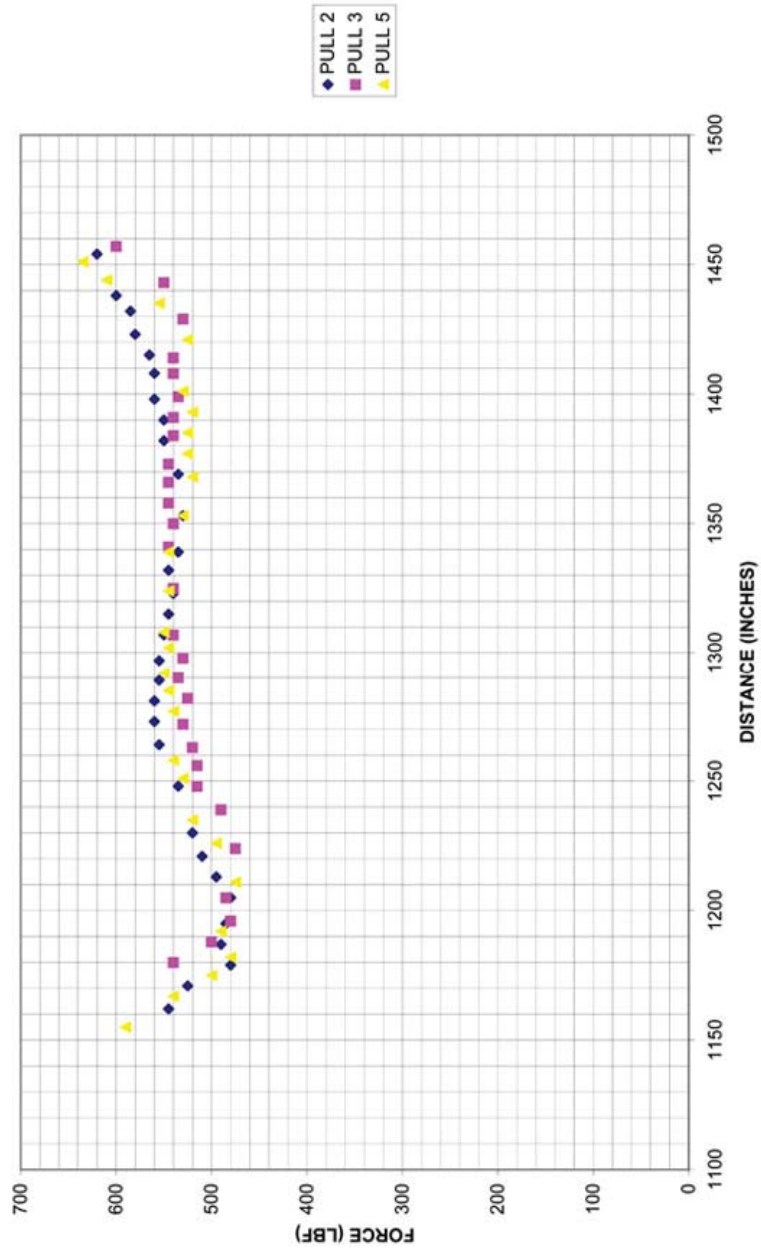
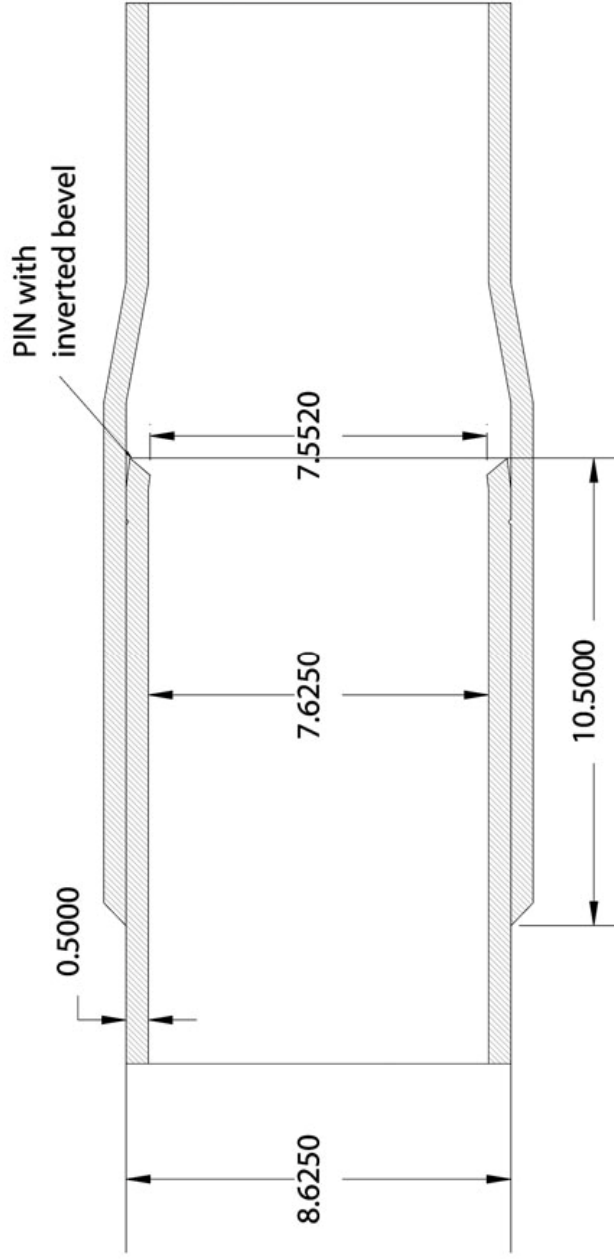


Figure 5



ZAP-LOK CONNECTION 8"
PIN WITH REVERSE BEVEL

Figure 6