PIPELINE MECHANICAL DESIGN REPORT

Z12/112996-ENG-RPT-00004. Rev 02

Client: LOTOS PETROBALTIC S.A.
Project Number: Z12/112996
Project Name: B8 GAS PIPELINE INSTALLATION ENGINEERING

Date	Revision	Description of Revision	Prepared	Checked	Approved
11.08.2016	**02**	**Issued for Construction**	**M. Morgan**	**G. Cowie**	**A. Cowie**

LOTOS Petrobaltic			**DOCUMENT COMMENT SHEET**
CLIENT: **Lotos Petrobaltic**	PROJECT : **B8 Gas Pipeline Installation Engineering**		Date : 13.06.2016
Comments : The response to : Installation Engineering Report Document			
Document Type : **Report**			
Document No.: **Z12/112996-ENG-PT-00004**		Revision : **03**	Date **: 04.07.2016**
Document Title : **Pipeline Feasibility Assessment Report**			
Received by : **M. Maciejewski**	Date : **13.06.2016**	Transmittal No. **CSL-OPS-P422-DTN-005**	

Item	**Reference**	**Comment**	**Comment By**	**Contractor's Response**
1.	Section 2.2 Larger DP Vessel	First paragraph, second sentence reads "The ship to ship transfer of loaded CT reel is expected to be 35 tonne reel (30 tonnes of pipe + reel weight say 5 tonnes). Estimated weight is a little bir different, average indication is presented in attachment to this document	A. Wojcikowski (21.06.2016)	Noted and will amiend to reference Tenaris weld location record for data on Coiled Pipe weight.
2.	Section 2.3 Dynamically Positioned (DP) Vessel vs Moored Vessel	First paragraph to be moved to end of section	M. Maciejewski (21.06.2016)	Noted and will amend accordingly
3.	Section 2.3 Dynamically Positioned (DP) Vessel vs Moored Vessel	Fourth paragraph, first sentence reads "It is expected that a 1.8km length of coil pipe could be laid in 2 to 6 hours from a DP vessel, subject to the vessel specification, <u>method used to monitor touch-down and weather conditions</u>." Is it really required, please let LPB know mechanism of monitoring, maybe we can propose another way of monitoring with distance measurement.	A. Wojcikowski (21.06.2016)	Yes, it is required. Monitoring TD by ROV is standard industry method. We expect the touch down point of the pipe onto the seabed to be continually monitored by a ROV. In the base case we would assume this would be deployed from the lay-vessel but it could be deployed from a work boat following behind the lay vessel.
4.	Section 2.3 Dynamically Positioned (DP) Vessel vs Moored Vessel	Fourth paragraph, second sentence reads "A lay speed for a moored barge is." Sentence not completed. Please up-date and added data for barge lay speed	M. Maciejewski (21.06.2016)	Noted and will amend accordingly
5.	Section 3.1 Abandonment Head	Third paragraph, second bullet point reads "The effect of cross currents on the pipe on the seabed" Does this effect exist in Baltic Sea states?	A. Wojcikowski (21.06.2016)	Noted and will amend accordingly

Item	Reference	Comment	Comment By	Contractor's Response
6.	Section 4.0 Zap-Lok™ Testing for Coiled Pipe	First paragraph, second sentence reads "However, to date there have not yet been any instances in which the Zap-Lok™ connection system has been used in conjunction with coiled pipe and while there is confidence that the Zap-Lok™ connection system would be able to be used with coiled pipe, it is recognize that there will be some variances." LPB need clarification on previous use of Zap-Lok™ connection with coiled pipe, as the understanding was it had successfully been used previously	A. Wojcikowski (21.06.2016)	Noted and revised paragraph wording to reflect further information obtained from NOV on Zap-Lok™ use on Coiled Tubing project
7.	Section 4.0 Zap-Lok™ Testing for Coiled Pipe	Second paragraph reads "It is recommended that the installation contractor carry out some proving trials in order to determine how these variances would be managed." Those variances could have big inpact in mechanical analysis. We are aware of.	A. Wojcikowski (21.06.2016)	Noted and amended to the following. *The principal issue is the ovality of the pipe, caused by the coiling process, therefore would recommend installation contractor conducts some testing to demonstate that the ovality of the pipe does not affect the ability to make a Zap-Lok™ joint*
8.	Section 4.1.1 Straightness	Second paragraph reads "It is recommended that the coiled pipe be straightened to meet the straightness requirements of line pipe, generally in accordance with API 5L." Are these requirements more strict than API 5LCP	A. Wojcikowski (21.06.2016)	Noted and will amend to include API 5LCP
9.	Section 4.1.1 Straightness	Third paragraph, third sentence reads "The aligner, a large bending "shoe" pre-bends the pipe entering the straightener to a known, fixed radius in order to maintain the pipe straightener at a constant setting as the reel is emptied of the pipe and also aligns the pipe with the face of the reel, so that the pipe can be wound levelly and smoothly on and off the reel." Please send us some photo, I think we have some problem with "naming"	M. Maciejewski (21.06.2016)	Noted and will amend wording to the following. *Traditionally, straightening Coiled Tubing pipe involves a two stage process. Firstly, the pipelay system would require a set of rollers to pre-bend the pipe to a fixed radius before entering the straightener in order to maintain the pipe straightener at a constant setting. The first set of rollers is at a fixed radius to the Reel inner diameter In order to maintain the pipe straightener at a constant setting and avoid requirement to re-adjust for each layer on the reel.*
10.	Section 4.4 Pull-Head	First paragraph reads "The Pipeline Installation Methodology Report Z12/112996-ENG-RPT-00005 assumes that the Abandonment and Recovery (A & R) winch could be used to draw the pipe off the new reel through the straightening rolls, through the Zap-Lok™ machine, after which the pull-head would be cut off in preparation for making the bell end." Please be informed that for A&R we will use support buoy from Resinex (data in attachment)	M. Maciejewski (21.06.2016)	This section refers to using the A&R winch during initial Coiled Tubing handling on vessel. Comment noted and will include reference to use of support buoy from Resinex in appropriate section within Pipeline Installation Methodology Report

REVISION RECORD SHEET

Date	Revision	Status	Reason for Change(s)
11.08.2016	**02**	**IFC**	**Issued for Construction**
04.07.2016	**01**	**IFA**	**See attached comment sheet(s)**
13.06.2016	**00**	**IFK**	**Issued for Review**

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1.0 INTRODUCTION

1.1 General

Lotos Petro-Baltic are planning an offshore gas pipeline which will connect a production platform located on the B8 field to a combined heat and power plant (CHP) situated onshore in Wladyslawowo. Prior to being transported in the pipeline the natural gas will be separated from the crude on the production platform. The platform is located in the Poland exclusive economic zone (EEZ) in the Baltic Sea. The B8 field spans an area of 387.1sqare km which was defined in the Concession No. 1/2006 on 5th September 2006 and amended by the Minister for the Environment No. DGiKGe-4770-69/4579/09/MO on 26 October 2009.

1.2 Objective

The objective of this report is to highlight areas where there are gaps in experience. In particular, to consider the feasibility of some aspects of the following:

- Installation Vessel selection
- Temporary Abandonment & Recovery of Coiled tubing during installation
- Using the Zap-Lok™ connection system in conjunction with coiled tubing pipe

1.3 Abbreviations & Nomenclatures

1.3.1 Abbreviations

Abbreviation	Description
A&R	Abandonment and Recovery
AHV	Anchor Handling Vessel
CT	Coiled Tubing
DP	Dynamic Positioning
EEZ	Poland exclusive economic zone
HOLD	Document hold point requiring additional clarification information
HSE	Health, Safety & Environment
ID	Inner Diameter
km	kilometre
m	metre
NDE	Non Destructive Examination
OD	Outer Diameter
QA	Quality Assurance
ROV	Remotely Operated Vehicle
TBC	To Be Confirmed

2.0 SCHEDULE IMPACT FOR INSTALLATION VESSEL SELECTION

The installation contractor shall take into consideration the cost effectiveness of different installation vessels.

2.1 Smaller DP Vessel

A smaller vessel will have reduced deck space available which would only be able to accommodate one or two reels, necessitating frequent port calls for restocking

2.2 Larger DP Vessel

A larger vessel will be able to accommodate more reels, having the advantage of an increased time on site, installing pipe and the possibility of restocking at sea, if the vessel has a suitable crane. The ship to ship transfer of loaded CT reel is expected to be an average weight of approximately 48,688 kg [107,340 lb] for 2,188m pipe 4.5" OD

- Coiled Tubing weight 42,338 kg [93,340 lb]
- Empty Reel weight 6,350 kg [14,000 lb]
- Calculation made from Tenaris Weld Location Record data sheet for LPB Coiled pipe in Appendix A.

It is not recommended to lift the reels at seas from one vessel to another due to the weight plus risk of damage to the reels. The lift capacity of a crane for a sea-lift usually requires a de-rating and thus a crane in excess of circa 150 tonnes capacity is anticipated, greater depending on the reach required and it may be feasible to consider the use of a floating crane with a capacity greater than 150 tonnes.

The risk of damage to the reel drive system is also increased and therefore to minimize this, a greater distance between the reel will be required, thus reducing the operational efficiency.

2.3 Dynamically Positioned (DP) Vessel vs Moored Vessel

The base case installation methodology is for a DP vessel. This is due to the reel lay method of deployment which achieve significantly higher speeds than a traditional pipe-lay barge which, based on discrete lengths of pipe being joined every 12-24m, only requires to move slowly.

A moored barge is likely to need 4 anchors, 2 forward and 2 astern, in order to maintain position and draw itself along the pipe-lay route. A barge which has not been built with this in mind would need to be modified to accommodate the anchoring system, including the need to provide motive power and this may impact the structural design of the deck, causing a need for additional stiffening and involvement of the vessel class, all of which is likely to impact both the budget and the schedule.
Periodically these anchors would need to be lifted and re-laid, which would require at least one AHV constantly to be in attendance to provide this support. Even if this support were to be provided by 2 AHV, a moored barge would not be able to match a DP vessel for speed of lay and the operational cost would be greater for this arrangement than for a DP vessel.

Subject to the vessel specification, the method used to monitor touch-down and weather conditions, it is expected that, once operational crews became familiar with the equipment, a 1.8km length of coil pipe could be laid in 2 to 6 hours, although to start with, we would expect the speed would be lower and for the initial schedule we have assumed 9 hours. The lay speed for a moored barge would be much slower even than this figure.

Monitoring TD by ROV is a standard industry method. We expect the touch down point of the pipe onto the seabed to be continually monitored by a ROV. In the base case we would assume this ROV would be deployed from the lay-vessel but it could be deployed from a work boat following behind the lay vessel and this provision may help manage the numbers of personnel on board the lay vessel. However, it may be possible also to monitor the pipe and the stinger using an underwater camera and observing the departure angle. The touch down point could be predicted by maintaining the departure angle within pre-established limits, using tables created during the analysis.

In conclusion, the feasibility of using a moored vessel for the entire pipe-lay operation introduces risk to the project in terms of technical, schedule and commercial considerations.

However, temporary use of a mooring system, particularly to improve station-keeping of a DP vessel in the shallow water, where the relationship between touch-down and vessel position is very sensitive, may be a worthwhile consideration and may be in the form of two pre-installed mooring lines, which could be picked up by the pipe-lay vessel and tensioned to stabilize its position.

It should be noted that none of the above issues, have any relevance to the type of connection system between each pipe section and thus are generic considerations.

For laying coiled pipe Lotos Petrobaltic prefers the use of DP vessel instead of a moored barge because a moored barge, which relies on Anchor Handling Vessel (AHV) to lift and re-lay the anchors, would be unlikely to match the rate at which coiled pipe could be laid. Instinctively, a moored barge with its attendant anchor handling tugs would incur more cost and lay too slowly, whereas a Dynamically DP vessel would appear to be a more cost effective option.

3.0 ABANDONMENT

3.1 Abandonment Head

The pipe end shall be abandoned in a way that does not require release or reconnection using a work class ROV. The preference would be to buoy off the abandoned end.

The installation contractor shall take into consideration the on-bottom stability of the abandoned end of the pipe.

In particular:

- The buoyancy of the pipe which would be installed gas filled
- The effect of cross currents, if applicable, on the pipe on the seabed
- The effect of cross currents, if applicable, on the abandonment rigging to surface buoy.
- The means by which a pull-head can be attached to the pipe end
- The means by which the end of the pipe is sealed to prevent ingress of seawater

There is a high risk of the pipeline sinking into the seabed in the offshore section which has soft clays and there is preference to avoid the use of a work class ROV. For these reasons the preferred method for laying down the pipe end would be to install a Zap-Lok™ pin connection with integral padeye, to which would be attached a pennant line with a surface buoy and this is the method shown in the Outline Installation Methodology document.

A review of the installation sequence would show there are opportunities to re-use cut-off pieces of pipe, which could have the end prepared as a Zap-Lok™ pin for this purpose.

3.2 On bottom Stability of Abandoned Pipe End

The base case installation methodology would be to install the pipe empty, gas / air filled.

The installation contractor shall take into consideration the magnitude of the cross currents and the effect they might have on the surface buoy, the pennant and the pipe line end and any tendency for this effect to cause the abandoned pipeline to become unstable on the seabed, thereby causing damage to the pipe.

4.0 ZAP-LOK™ TESTING for COILED PIPE

The Zap-Lok™ pipe connection system has been used successfully during the installation over 6000km of offshore subsea pipelines and has been developed for standard lengths of line pipe. The Zap-Lok™ pipe connection system has been used to connect coiled tubing in the past. We understand from historical track record provided by NOV Zap-Lok™ that Shell used the connection on downhole coiled tubing applications in the late 1980s. Also, there is use of coiled pipe being connected by Zap-Lok™ in shallow water in USA, although NOV Zap-Lok™ were unable to provide details.

The principal issue is the ovality of the pipe, caused by the coiling process, therefore would recommend installation contractor conducts some testing to demonstrate that the ovality of the pipe does not affect the ability to make a Zap-Lok™ joint.

It is recommended that the installation contractor carry out some proving trials in order to determine how these variances would be managed, as discussed further in the next section.

4.1 Pipe Shape

4.1.1 Straightness

The pipe will require to be straightened as it comes off the reel. This is to minimise the residual curvature in the pipe, which if not corrected may lead to excessive twist in the pipeline during deployment and to ensure the straightness is within tolerance for the Zap-Lok™ connection.

It is recommended that the coiled pipe be straightened to meet the straightness requirements of line pipe, generally in accordance with API 5LCP.

Traditionally, straightening Coiled Tubing pipe involves a two stage process. Firstly, the pipelay system would require a set of rollers to pre-bend the pipe to a fixed radius before, secondly entering the straightener to then reverse bend into straight line. The first set of rollers is at a fixed radius to the Reel inner diameter in order to maintain the pipe straightener at a constant setting and avoid requirement to re-adjust for each layer on the reel.

The straightener, comprising fixed reaction rolls and movable bending rolls, would reverse bend and straighten the pipe as it comes off the first set of rollers.

However, because of its size and the need to minimize length, it may be difficult to incorporate an aligner into the firing line with the result that the straightener would need to accommodate the change in pipe curvature as it reduces for each successive wrap toward the drum.

The contractor shall demonstrate the ability to meet these requirements or, in the absence of being able to do so, shall demonstrate the ability to make Zap-Lok™ connections at the best straightness which can be achieved. In particular, attention should be paid to the change in the radius of curvature of the pipe, which will reduce at each successive layer towards the centre of the reel.

It is recommended that demonstration trials be carried out.

4.1.2 Profile of Rollers

It is recognized that the coiling process induces some degree of flattening, causing the pipe to adopt a slightly oval shape in which the major and minor diameters might differ. Also, the force applied by the straightening rolls may have a tendency to cause ovality of the pipe during the straightening process.

These two features shall be shall be taken into consideration when defining the profile of the straightening rolls.

4.2 QA longitudinal weld post belling of the pipe end

Consideration shall be given to confirmation of the integrity of the belled end of the pipe and the longitudinal weld, to ensure no damage has occurred as a consequence of the belling process. It is recommended that Non Destructive Examination (NDE) be carried out post belling at least once for each mill run of pipe.

4.3 Pipe Ends

The standard Zap-Lok™ connection comprises one end which has been deformed into a socket (bell) and the other end which has been deformed into a pin. To date, there has been no experience of Zap-Lok™ ends having being made on coiled pipe. The belling process is unlikely to present any concerns because the bell socket is plastically deformed by the insertion of a mandrel and this would be likely to rectify any ovality.

However, the pin end is made by a machine which relies on the existing profile of the pipe during the generation of a pin end.

Because of the uncertainty in being able to make a pin which conforms to the Zap-Lok™ tolerances at the end of coiled pipe, the installation methodology makes the assumption that the Zap-Lok™ joint will be accomplished by making a bell at each end of the coiled pipe and using a straight PUP piece, with a pin at each end. Hence, the base case is to use a pup-piece which will have the 'pin' at each end. This will mean the reeled pipe end will all be formed as bells. This arrangement is the base case since the abandonment and recover head will use the same approach.

In addition, this will negate the need for coating removal of the reeled pipe to form the pin end and eliminate any concerns regards the residual ovality of the pipe following the reeling and straightening process.

It is recommended that the installation contractor review this assumption. At his discretion testing may be carried out to examine the validity of the foregoing assumption. It would be expected that the testing would either confirm the validity of the assumption or would establish that indeed, a pin conforming to the Zap-Lok™ tolerances can be made in coiled pipe.

If the outcome of this testing on sections of coiled shows that a pin can be made successfully, it is likely to affect the process summarized in the, described under a separate cover.

4.4 Pull-head

The Outline Installation Methodology assumes that the Abandonment and Recovery (A & R) winch could be used to draw the pipe off the new reel through the straightening rolls, through the Zap-Lok™ machine, after which the pull-head would be cut off in preparation for making the bell end.

The installation contractor would need to develop a mechanism whereby the end of the A&R winch wire can be attached to the new pipe end.

4.5 Relative motion between pipe and firing line components

4.5.1 Vessel induced movements

It is expected that relative movement between the pipe and the firing line equipment will occur either by the tendency of the vessel to surge, oscillate back and forth a little as a consequence of computer control for Dynamic Positioning (DP) or, as a consequence of the behaviour of the tensioner.
The pipeline analysis report indicates that in shallow water the vessel needs to keep station to within +/- 1 metre.

The installation contractor shall take into consideration the means by which this relative movement can be accommodated.

One of the options would be to incorporate the Zap-Lok™ press on a movable platform (rendering table) to accommodate this movement. An alternative mechanism might be to employ seabed anchors as a means of limiting the motion of the installation vessel.

4.5.2 Zap-Lok™ induced movements

The forward clamp of the Zap-Lok™ press, moves backwards about 150mm to push the pin and bell of the Zap-Lok™ connection together and it is important to ensure that this travel is not impeded by the behaviour of the reel drive system.

The installation contractor shall ensure that during the make-up of the Zap-Lok™ joint, the forward clamp of the Zap-Lok™ press is able to travel unrestricted by the behaviour of the reel drive.

4.5.3 Movement during Zapoxy setting

The installation contractor shall ensure that once the joint has been made up in the Zap-Lok™ press the newly made joint is not subjected to any axial loading for a minimum duration of 5 minutes.
During the curing time it is important for its future integrity that the newly made joint is not subjected to axial loads, during the curing time, while the properties of the Zap-oxy compound change from fluid, for lubrication, to solid for adhesion.

This requires the following operational conditions during setting:

(i) Zap-Lok™ clamps shall remain closed
(ii) Relative movement between the firing line components and the installed pipe

Either this is accommodated by the travel of the rendering table together with the reel drive applying a very low constant tension to allow rotation of the reel in either direction. The constant tension load must be low enough that it does not overcome the frictional resistance provided by the clamps of the Zap-Lok™ press.

Or by restricting the ships movement by an arrangement of stern anchors and forward thrust anchors.

4.6 HSE

The installation contractor shall prevent marine pollution owing to use of chemicals involved in the process for preparing Zap-Lok™ pipe ends for pinning and belling and if required, any solvents used to prepare for applying Zapoxy by bunding and capturing the washings.

4.7 Coating

In order to determine whether or not the coating needs to be removed, the Installation Contractor shall understand the behaviour of the coating in the following circumstances and in particular its ability to remain in adhesive contact with the pipe under all loading conditions where the pipe is subjected to clamping or gripping forces.

Interface with the clamps of the Zap-Lok™ press and other clamps which might be used for temporary security as hold-back devices

4.7.1 Diameter

To ensure the coated pipe fits the Zap-Lok™ press clamps the clamps close properly over the coated pipe

4.7.2 Shear Strength

To ensure the coating remains in adhered to the pipe when the pipe is subjected to axial loads, specifically during make-up of the joint in the Zap-Lok™ press.

Trials will be performed on a section of the pipeline with the coating attached to determine the maximum force that can be applied to the coating. It is not expected that the coating will adhere sufficiently to resist the make-up forces for the Zap-Lok™ connection; hence the base case is that the PP coatings will be removed prior to Zap-Lok™ joint make-up.

5.0 Stinger

The length of the stinger has been established in the analysis report.

The installation contractor shall consider the following interacting issues as part of feasibility of laying pipe with this stinger:

- Minimum feasible depth of water
- Maximum allowable met-ocean conditions, wind speed, wave height,
- Availability of suitable met-ocean conditions to suit specifics of installation vessel.

APPENDIX A – TENARIS WELD LOCATION RECORD

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Tenaris

Shipping

WELD LOCATION RECORD

Shipping Spool

SPOOL TYPE **Metal**

SPOOL SIZE 232-170-112

SPOOL ID NO 7702

Meters	Feet	Gauge	Strip Number
262.13	860	.250	2377122-4
397.76	1305	.250	2377122-3
396.24	1300	.250	2377122-2
390.14	1280	.250	2377122-1
399.29	1310	.250	2377101-3
342.90	1125	.250	2377101-4

STRING NUMBER **35379**

GRADE API-5LCP-X65-C

SIZE 4.50

SALES ORDER NO. 36006868

DATE COMPLETED: 4/24/2015

SHIPPED TO LOTOS Petrobaltic S.A.

P.O. NUMBER FH/ZP-12/2013

TOTAL FOOTAGE 7,180

TOTAL METERS 2,188.46

EST TUBING WT	93,340
EST SPOOL WT	14,000
EST CWR WT	
EST TOTAL WT	**107,340**

FITTING LOCATION N/A

FITTING TYPE N/A

FITTING I.D. NO. N/A

COMMENTS:

AWS Richard Hill
CWI 14093141
QC1 EXP. 9/1/2017

[ ]Anti roll Block

/ Indicates CM (Continuously Milled) type weld

Prepared By KW

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