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A Discussion of the Effect of the Reeled Installation Process on Pipeline Limit States

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ABSTRACT

Pipeline reeling is a well established method for offshore installation of rigid steel pipelines and risers. The basic process of loading stalks of pipe that have been fabricated onshore onto large reels before transit to the worksite, unspooling, straightening and lay is generally well known. However, less well understood is the mechanics of the process. This occasionally leads to concerns that a reeled pipeline has somehow been degraded by the process and must be down-rated in comparison to a similar line installed by J-lay or other methods. This paper addresses these concerns by asking and answering the question; "Does the reeled installation method introduce a greater risk of failure in-service than other installation processes?" The argument is constructed by assessing each limit state, meaning the fundamental ways that a pipeline can fail (burst, collapse, fracture), and considering the possible effect that reeling may have on each during service. The paper concludes that there is no general reduction in pipeline performance as a result of the reeled installation method, provided that certain items are considered during design, procurement and fabrication process. The paper makes use of a wide range of supporting data from extensive in-house engineering and testing program, reference to relevant Joint Industry Projects (JIPs) and a large reel-lay installation track record including some of the largest or deepest reeled pipes in both the Gulf of Mexico and West of Africa.

KEY WORDS: Pipeline, Reeling, Limit State Design

NOMENCLATURE

D_{nom}	Nominal outside diameter
R	Reel hub radius
$t_{coating}$	Thickness of coating / insulation
t_{min}	Minimum reelable wall thickness
t_{nom}	Nominal wall thickness
t_{tol}	Negative wall thickness manufacturing tolerance (%)
$\Delta\varepsilon_{nom}$	Nominal (total) bending strain range
$\varepsilon_{b\text{-}nom}$	Nominal (total) bending strain

INTRODUCTION

Reeling is a fast, reliable and cost effective method for rigid pipeline installation. The individual pipeline joints are fabricated onshore onto long stalks of pipe before being spooled onto large reels. Performing the fabrication welds onshore, away from the vessel critical path, allows very high quality welding to be undertaken. It is then transited offshore and installed. Technip track record includes the first ever reeled SCR (steel catenary riser) and reeled pipe-in-pipe in water depths exceeding 2000 m (see e.g. McLean, 2001; Bell & Daly, 2001). The reeling process is described in Fig. 1 using a moment-curvature curve. It comprises of five steps:

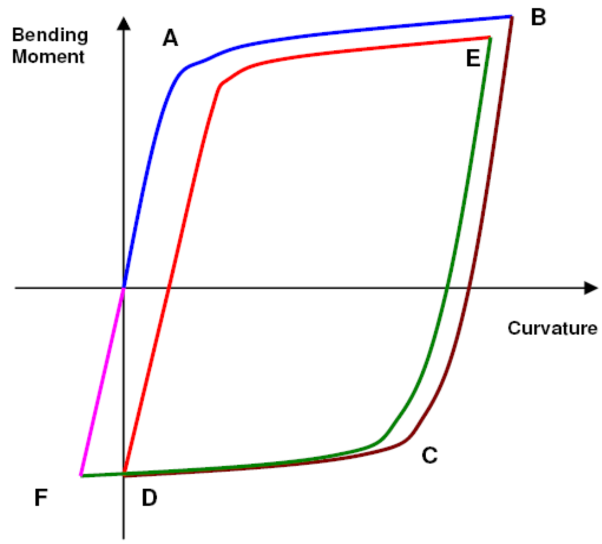

Fig. 1 – Schematic of different steps of the reeling process

- Step 1: The pipeline is spooled from the quayside onto the reel. It is taken past the yield point (A) to finally adopt a maximum curvature (B), equivalent to the radius of the reel hub. The radius of curvature increases with the number of spooled wraps.
- Step 2: During unspooling offshore, the pipeline first spans from the reel to the aligner. Through this stage, the pipeline is approximately straight in the span (D), due to the combination of pipe self weight and applied back tension. There is reverse plastic deformation associated with this straightening (C), but some residual curvature remains.
- Step 3: The pipeline is then re-bent in the same direction as the original plastic deformation over the aligner wheel. The curvature is always equivalent to the radius of the aligner wheel (E), irrespective of whether it is at the start or end of the line.
- Step 4: The pipeline is then subjected to a reverse plastic bend (F) in the three-point straightener arrangement. This reverse curvature is carefully selected to ensure that, when the pipe is relaxed, it is