

Qualification of Weldable X65 Grade Riser Sections with Upset Ends to Improve Fatigue Performance of Deepwater Steel Catenary Risers

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ABSTRACT

This paper presents the design and qualification work undertaken for the development of seamless and weldable X-65 grade riser sections with thick upset ends. This is one of the four solutions developed and qualified in a JIP during 2004 to 2007. The development effort focused on their application as a design solution for fatigue improvement at the touch down zone (TDZ) of a steel catenary riser (SCR). The manufacturing of riser sections with thick upset ends with weldable properties provided challenges, and required specific set of tooling and considerations in chemical composition, manufacturing and heat treatment processes to obtain the required performance. The proof of weldability of very thick upset ends was done as per API RP 2Z procedures, and welding procedures were developed with select weld consumables, weld type, and surface conditioning for use in full scale fatigue tests.

TenarisTamsa undertook manufacturing of samples and qualification testing program for two 273.1 mm outer diameter (10.75" OD) production riser cases with varying thickness and performance requirements for upset ends, per JIP case studies for applications in deepwater Gulf of Mexico and West of Africa. The design development and qualification work included alloy design, upsetting tool design, development of a welding procedure specification, definition of industrial manufacturing route, conventional destructive, fracture mechanics and corrosion testing, girth welds fabrication for qualification and for full scale fatigue tests. These are summarized and key results and findings are presented for two cases.

Through this effort the feasibility of upsetting riser sections with very thick ends and their weldability and fatigue performance have been proven. In addition, an improved procedure for onshore/shop welds at thick upset ends has been qualified with its ability to significantly increase the fatigue performance. The Technology Readiness Level (TRL) of this solution has been improved and it is available for use in deepwater projects.

KEY WORDS: SCR; TDZ; deepwater; fatigue; qualification; welding; X65; sour service; riser; upset pipe.

INTRODUCTION

An important design consideration for steel catenary risers (SCRs) in deepwater and ultra-deepwater applications is to ensure adequate fatigue life of the girth welds at the touch-down zone (TDZ) region, where the riser leaves the seafloor. Constant motion of the floating system to which the SCR is tied results in cyclic pounding of the riser against the sea-floor, which lead to significantly higher fatigue damage at TDZ riser sections and welds. The fatigue damage becomes more severe due to several other parameters, such as the riser diameter (large), fluid type (sour service), and water depth, which in some cases lead to selection of other riser designs instead of SCR. In many applications, additional measures (construction, design, operational) were implemented to reduce the stress concentration factor (SCF) at TDZ welds or reduce fatigue damage at welds.

TenarisTamsa joined as a Contributing Participant in a joint industry project (JIP) initiated by KBR/Granherne Americas to address this issue. The JIP undertook development and qualification of four (4) alternative design solutions to significantly increase the fatigue life at TDZ (Aggarwal, Izquierdo et al, 2007; Aggarwal, Mourelle et al, 2007; Aggarwal, Meling et al, 2006; Aggarwal, Baxter et al, 2008). The solutions undertaken are grouped as follows:

- X-65 grade solutions (thick light weight coating, and riser sections with upset ends)
- High Strength Solutions (riser sections with integral threaded connectors, and titanium segment with flange connection)

TenarisTamsa undertook the design development and qualification tasks for riser sections with upset ends for two (2) design cases to confirm feasibility of this solution for a range of SCR sizes. This paper presents the overall work done to develop and qualify this solution and key results are discussed.