Experience with the design and installation of Steel export lines for deep water projects

Hervé Quintin
Acergy.
Suresnes, France

ABSTRACT.

This paper presents the experience gained from different West Africa projects to design, procure and safely install steel offloading lines to export oil from floating production units in deepwater. Some critical aspects of the design are presented but focus is given to fabrication issues including pipe fitting, weld qualification and offshore fabrication in order to highlight the main steps to install these lines successfully.

KEY WORDS: offloading lines; risers; welding; installation.

INTRODUCTION

This paper presents the experience gained from different West Africa projects to design, procure and safely install steel offloading lines to export oil from floating production units in deepwater. In such very deep water configurations, transferring the oil to an offloading system through a system of risers and sea bed pipeline is both very expensive and inefficient from a headloss point of view. Suspended steel risers between the FPSO and an offloading buoy present a cost-effective solution for offloading systems. Steel line solutions offer a large choice of line diameter, a limited head loss due to friction and are in general lighter than flexible line. Reduction of the offloading export pressure at the FPSO leads to an increase of the line diameter and as a consequence to an increased sensitivity to the fatigue due to the waves, buoy and FPSO motions.

This paper highlights the main requirements in terms of design and fabrication constraints and develops the strategy put in place to be able to install these lines successfully. The following subjects are discussed in detail:

- Design optimization of the coupled system «FPSO – Offloading lines – Offloading buoy including its mooring lines – Offloading Tanker»
- Fatigue life requirements,
- Pipe manufacturing tolerances in order to minimize high-low and increase fatigue life of the welds
- Welding procedure qualification
- Onshore preparation of the different components including installation equipment qualification tests,
- Offshore installation of the lines using a S-lay type configuration including initiation to the FPSO, transfer to the offloading buoy, and final flooding of the lines.

DESIGN OPTIMIZATION

Offshore loading systems for deepwater developments present the following characteristics:

- An offloading buoy located approximately at one nautical mile from the FPSO with the capability to moor 350 000 DWT tanker up to 10-year environmental conditions,
- Two or three lines suspended between the FPSO and the single offloading buoy allow transfer of produced oil to the offloading tanker.
- An offloading rate generally defined to allow the transfer of 1 million barrel in about 1 day, which is equivalent to about 42000 bbl/hour (6500 m³/h). The offloading pressure available at the FPSO is governed by the booster pumps capacity and also by the electrical power available on the FPSO. Pressures between 15 barg to 30 barg are the most common values.

Based on these parameters the design phase of the offshore offloading system consists mainly in the optimization of the system in terms of technical feasibility, interface loads at the buoy and FPSO sides, availability and capacity of the installation vessel and procurement cost. The following parameters are the main variables that can be modified during this optimisation process:

- Offloading Line size and number,
- Offloading Line length,
- Offloading Line shape.

Offloading line sizing

Selection of the line internal diameter and line number is only driven by the hydraulic analysis of the system and by the available FPSO outlet pressure. The following figure (fig.1) gives an estimation of the outlet...