ABSTRACT

The proposed paper is going to review and assess the different ways of achieving more robust mooring system as requested by some operators/contractors. This review is not limited to design activities but also integrates impacts of procurement, transport, installation and operation phases onto the overall integrity of such mooring system. In addition the benefits of proper Asset Integrity Management System associated with Inspection and Monitoring programs throughout the life of the installation will be highlighted. Also identifications of some key areas will be presented, such as corrosion, where a better understanding/knowledge of the involved phenomena will lead to a noticeable improvement of Integrity. Finally the paper is going to compare variations in the design of a mooring system based on different levels of design reliability target, for two typical mooring systems in Cyclonic area.

KEY WORDS: Mooring; Design; Procurement; Installation; Inspection; Asset Integrity Management Plan; Monitoring.

INTRODUCTION

The potential environmental and economic consequences of a mooring system failure demands careful consideration and understanding of the achieved level of integrity of the mooring system in terms of strength and motion extremes.

It is clearly identified that mooring systems on Floating Production Systems are category 1 safety critical systems (Noble Denton Europe Limited, 2006). Multiple mooring line failure could put lives at risk both on the drifting unit and on surrounding installations. There is also a potential pollution risk. Research to date indicates that there is an imbalance between the critical nature of mooring systems and the attention which they receive.

The proposed paper is reviewing the various steps necessary to design, procure, transport and install a mooring system while maintaining the same level of integrity. It is no use to carefully design a mooring system while the transport or the installation may damage some of the components. Enforcing integrity is an overall process and needs to cover the whole range of such various activities for consistency purposes. Furthermore, the in-situ performance of such mooring system needs to be included in the whole integrity assessment. And proper monitoring shall be put in place.

As such the aim of the present paper is not to assess the theoretical reliability level achieved by design activities and the ways to increase such number, but to highlight the need of consistent level of care from design throughout installation activities, in order to achieve an overall satisfactory level of robustness, for permanent mooring system.

DO MOORING LINES BREAK?

Steel wire rope and chain have been used for mooring floating offshore production systems since their introduction more than 30 years ago (1st FPSO: Castellon Delta for Shell in 1976). A recent survey (Noble Denton Europe Limited, 2006) of past and presently operating FPS units has shown that serious incidents have occurred in the past, including loss of station. The survey has also shown that even for more up to date designs, deterioration of certain areas of the moorings systems may be more rapid than expected. Some of these failure mechanisms had not been anticipated during design or even envisaged, and illustrate that existing practices in design, procurement, installation and subsequent monitoring could benefit from being more robust and consistent with each other in terms of achieved integrity.

Data published by the UK HSE (DNV Industry AS, 2003) suggests an average historical rate of FPSO mooring failure about once every 7 operating years, of FSU mooring failure about once every 17 operating years, of Drillship mooring failure about once every 1.5 operating years, of Drilling Semisubmersible about once every 4 operating years, and of Production Semisubmersible about once every 8 operating years.

The following trends have been identified:

- Most failures have been associated with terminations, fairleads, connectors, pin retention details (i.e. “one off” design details not standard chain/wire elements).
- There have also been similar “one off” defects with turret systems.
- Where there have been line failures there has typically been evidence of degradation in all similar components.
- The causes have included poor detailing, fatigue sensitivity, inadequate corrosion protection, inappropriate materials and lack of adequate manufacturing process.
- Most of the failures first appeared within the first three years of