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Guidance on Industry Standard for Offshore Pipeline Span Analysis (Supplement to DNV RP F105)

GIS 43-213

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of BP Engineering Technical Practice (ETP) BP GIS 43-213. This document is updated on a periodic basis to include new BP experiences and any additional mandatory requirements. This is not a standalone document; it must be used in accordance with the requirements of ETP document PR 43: Pipeline ETP Rationale and Philosophy. In addition to the requirements for this document, those of relevant BP group standards such as HSSE policy and Process Safety/ Integrity Management standard (PS/IM) must also be fulfilled.



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Introduction

- a. Guidance for offshore pipeline span analysis is based on DNV RP-F105.
- b. Guidance statements of this GIS are modifications to DNV RP-F105, Free Spanning Pipelines, February 2006.

Issues discussed are based on experience from BP and other industry sources.

BP provided comments to DNV during the update to the 2006 edition of DNV RP-F105. The text and Guidance Notes within DNV RP-F105 include these comments and so they are not repeated in this document.

- c. Modifications to DNV RP-F105 contained in this document are identified as Add, Modify to Read, or Delete.
- d. Paragraph numbers in this document correspond to DNV RP-F105.
- e. Paragraphs of DNV RP-F105 that are not revised remain applicable.
- f. If any statement is contradictory to DNV RP-F105, the requirements of this GIS shall take precedence.
- g. The technical integrity of all aspects of design, construction, and operation of pipelines is of the highest importance to BP and compliance with BP HSSE policy shall remain paramount.
- h. When this standard is applied in regions where the application of DNV RP-F105 is mandatory, criteria herein which effectively reflect a concession to the standard should be discussed with appropriate regulatory and legislative authorities to ensure their agreement to implementation.



Foreword

Relationships to Rules under preparation

Add

SAFEBUCK JIP.

Neither RP F110 nor RP C205 have been reviewed in detail by EPTG.

Lateral buckling of pipelines can also follow the SAFEBUCK JIP guidelines, which have been used by BP on a number of projects Offshore Angola and Gulf of Mexico.

Motives

Modify to Read

The earlier design code, DNV RP-F105 for “Free Spanning Pipelines” issued in March 2002, could be effectively applied to deal with both single and multiple spans vibrating predominantly in a single mode. In the case where there is a combination of long spans and high currents, not only do the fundamental eigen modes become activated, but also the higher modes. Such a multimode response was not prohibited by the design code. However, no detailed guidance was provided in the earlier Recommended Practice (RP) about the fatigue damage from multimode vibrations.

During the Ormen Lange project a strong focus was put on design procedures for long free spans in order to make this project feasible and in order to save seabed intervention costs. A relatively large R&D project on free span vortex-induced vibrations (VIV) was performed. The results of this project were synthesised into a project specific guideline issued by DNV, concerning the calculation procedures and design acceptance criteria for long free spans with multi-mode response.

The main objective of the updated DNV RP-F105 for “Free Spanning Pipelines” issued in February 2006 is to include the experiences gained from the Ormen Lange Project regarding multi-mode and multi-span response and incorporate the latest R&D work relating to Free Spanning Pipelines. This proposal was worked out through a JIP with Hydro and Statoil. In addition to the multi-mode response aspects, a general update and revision of the DNV RP-F105 has been performed, based on feedback and experience from several projects and users.

As a partner in the Ormen Lange Development, BP were part of the Span Assessment Guideline development and details of the testing performed are available within BP EPTG.



1 General

1.2 Objective

1.2.1 Add

A span determined as acceptable to this RP should be evaluated for interference with other legitimate users of the sea.

1.3 Scope and application

1.3.10 Modify to Read

Procedures and criteria for structural design or assessment of free spanning HT/HP pipelines have not been included within the scope of this Recommended Practice.

Free spans due to uplift are however within the scope of this document.

Note:

For information regarding procedures and criteria for structural design or assessment of HP/HT pipelines, please refer to either DNV RP-F110 or the SAFEBUCK JIP.

For free spans caused by upheaval buckling fatigue due to the change in shape of the span as operating conditions change would be expected to be more significant than Vortex Induced Vibration (VIV). The assessment of these spans will therefore need detailed finite element analysis modelling the pipeline history. Failures have been induced by supporting these spans whilst the line is operating since significant tension is then induced in the line when it is shut down. Specialist assistance should be sought when free spans caused by upheaval buckling are assessed.

1.4 Extending the application scope of this RP

1.4.3 Add

GP 65-72 Riser Vortex-Induced Vibration Design Guidelines

GN 65-704 Riser Fatigue Calculation

1.5 Safety philosophy

1.5.2

Specialist assistance should be sought if project specific safety factors are intended to be developed.

1.11 Relationship to other Rules

The relationship of DNV RP-F105 with other pipeline design codes is discussed in Appendix E.

2 Design criteria

2.2 Non-stationarity of spans

2.2.3

Data from more than one survey is needed to assess scour induced free spans. It has been found that supporting scour created spans can induce additional loading in the line and prevent a self burial mechanism from occurring.



2.3 Screening fatigue criteria

2.3.5

BP EPTG have a license for FATFREE Current, the DNV Design Tool for performing fatigue analysis under current alone. This RP statement implies that this can be used to assess fatigue under current and wave action by adding the wave induced flow and current. This has not been verified.

2.4 Fatigue criterion

2.4.4 Add to the list of SN curve sources

- Pipeline Design Code SN Curve.

2.4.10

The approach described in the RP can be extended to account for independent current and wave directions by characterising a seastate by $(H_s, T_p, \theta_w, U_c, \theta_c)$.

2.5 ULS criterion

2.5.2 Add to 'horizontal direction' list

- lateral deformation of HPHT pipelines (lateral buckling)

2.6 Safety factor

2.6.7

A similar approach can be followed to convert the effective fatigue damage to other design codes.

3 Environmental conditions

3.3 Short-term wave conditions

3.3.5

The DNV OPT 98 paper by Mork and Fyriliev notes that the frequency domain fatigue method compares well with the time domain method "for moderate to deep water" but that "the conclusion does not hold in general". The range of water depth validity is not given and should be assessed if the method is applied in shallow water.

3.5 Long-term environmental modelling

3.5.2

The way that the extreme current data are developed from tidal and storm components needs to be fully understood to establish the probability distribution to be used in the fatigue analyses.

4 Response models

4.1 General

4.1.3

As a partner in the Ormen Lange Development, BP were part of the Span Assessment Guideline development and details of the testing performed and the basis of the models developed are available within BP EPTG. It is noted that the method proposed in Appendix A of the RP was calibrated for the Ormen Lange pipe

