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TITLE: ON-BOTTOM STABILITY ANALYSIS



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1. INTRODUCTION

1.1. SCOPE

This Technical Specification has the objective to establish the minimum scope of work, minimum technical requirements and minimum deliverables related to the on-bottom stability analysis of rigid subsea pipelines.

The contents of this Technical Specification applies to the on-bottom stability analysis of pipelines due to hydrodynamic loads only. Other on-bottom stability issues, e.g. axial stability and slope stability, are out of the scope of this document and shall be addressed according to the codes and standards adopted for the pipeline design.

1.2. GENERAL

The requirements of this specification are supplemental to the requirements of references [B 1] and [B 2].

In addition to the required analyses and premises established in this Technical Specification, CONTRACTOR shall perform and include on the deliverables, all analyses judged necessary, based on its previous experience, particularities of the project and good engineering practice, to assure safe operations and pipeline integrity.

1.3. DEFINITIONS

The following definitions are used for the purpose of this Technical Specification.

Absolute stability	A pipeline is absolutely stable if it does not experience any displacement from its as-installed position due to environmental actions
CONTRACTOR	The company responsible for the on-bottom stability analysis of subsea pipelines
Dynamic stability	A pipeline is dynamic stable if it does not experience displacements from its as-installed position larger than an allowable limit due to environmental actions
Hs	Significant wave height
Tp	Peak period
Rigid Pipeline	A continuous line of steel linepipes of any length without frequent branches used for transport fluids
Virtual stability	A pipeline is virtually stable if it does not experience displacements from its as-installed position larger than half the pipe diameter due to environmental actions

2. STABILITY CRITERIA

The aim of on-bottom stability analysis is to assure that pipeline will not experience displacements due to hydrodynamic loads that may compromise integrity and operation of the pipeline as well as of adjacent structures and lines and/or are larger than the acceptable by the project specification.

To assure the pipeline stability the following criteria must be used:

- Absolute stability;
- Virtual stability;
- Dynamic stability.

Table 2.1 indicates the accepted criteria for each pipeline region.

Regions	Criteria		
	Absolute Stability	Virtual Stability	Dynamic Stability
Regions with lateral slope or regions with current dominated hydrodynamic loads	X ¹		
Regions with crossings, tie-ins, in-line structures, free span supports or lateral buckling susceptibility.	X	X	
Other regions.	X	X	X ²

Table 2.1: stability criteria acceptance.

Notes:

- 1- For regions with lateral slope the absolute stability criteria from ref [B 2] shall be modified to take into account the weight components normal and tangential to the soil on the force equilibrium.
- 2- Dynamic Stability criteria may be apply only for operational conditions. The pipeline design shall meet the absolute stability or virtual stability criteria for all other phases, including installation and pre-comissioning phases.



3. ENVIRONMENTAL DATA

For each recurrence period and water depth, the most critical Hs and Tp combination shall be selected from the environmental contours on the environmental data technical specification.

4. COMPUTER PROGRAMS AND SPREADSHEETS

The following software is accept for verification of virtual and dynamic stability criteria:

- PRCI Pipeline On Bottom Stability version 3.0 [D 1].
- DNV STABLELINES Spreadsheet

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For stability analyses using PRCI Pipeline OBS [D 1] software the following restrictions applies:

- In addition to the appropriate lateral stability safety factors, the vertical stability safety factor calculated by the program shall be greater than 1.0 for all conditions.
- Level 3 analyses shall not be used for loose sands and soft clays ($S_u < 6.0$ kPa, $D_r < 0.6$).

Absolute Stability calculations may be performed with DNV STABLELINES spreadsheets or in-house developed and verified tools.

The use of other computer programs shall require PETROBRAS agreement.

5. DELIVERABLES

5.1. DOCUMENTS



All documents shall include, but shall not be limited to the following initial items:

- Field description;
- Objective;
- Executive Summary;
- Input data;
- Stability criteria;
- Results;
- References;
- Annexes

Input data item shall present all information necessary to reproduce the analysis results.

All documents shall be issued in accordance with the latest revision of PETROBRAS standards indicated on references [A 1], [A 2] and [A 3].

Annexes item shall include all Input and output files from PRCI Pipeline OBS [D 1] analyses and input and output from spreadsheet calculations.

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6. REFERENCES

- [A 1] N-381 – Execução de Desenho e Outros Documentos Técnicos em Geral.
- [A 2] N-1710 – Codificação de Documentos Técnicos de Engenharia.
- [A 3] N-2064 – Emissão e Revisão de Documentos de Projeto.
- [B 1] DNVGL-ST-F101 – Submarine Pipeline Systems.
- [B 2] DNVGL-RP-F109 – On-bottom Stability Design of Submarine Pipelines.
- [B 3] DNVGL-RP-C205 – Environmental Conditions and Environmental Loads.
- [C 1] I-ET-0000.00-0000-940-P9U-003 THERMO-MECHANICAL DESIGN OF SUBSEA PIPELINES.
- [D 1] SUBMARINE PIPELINE ON-BOTTOM STABILITY, PRCI PROJECT PR-178-04405.