



**BUREAU
VERITAS**

PIPELINE ANALYSIS SOFTWARE ASSESSMENT

SAGE PROFILE v3.0

Certificate n° E&P/12209-C-2015-01Rev.0

Contract 27 March 2006 TECHNICAL SERVICES AGREEMENT between FUGRO Belgique/België SA/NV and BUREAU VERITAS Marine & Offshore

Software SAGE PROFILE version 3.0

Description Finite Element Software for Pipeline Analysis (3D configuration of pipeline on uneven seabed, free span profile, global buckling set-in)

The Undersigned, acting within the scope of the Bureau Veritas General Conditions of Service, hereby CERTIFY that the above mentioned SAGE PROFILE v3.0 Software, developed by FUGRO Belgique/België SA/NV, has been technically scrutinized by Bureau Veritas, and found giving sufficiently reliable stresses / forces / displacements results for the use in steel subsea pipelines design, on basis of the following analyses:

- Assessment of the general theory of the non-linear behaviour of pipeline elements and their interaction with seabed soils, through comparison with analytical solutions (beam theory calculations with parametric studies).
- Calculations of realistic cases under load combinations which lead to non-linear behaviour, and results comparison with referenced non-linear finite elements software for, amongst others: pipeline expansion analyses, free spans predictions, global instability detections (i.e. location prone to upheaval buckling)
- Calculation of an existing steel pipeline, and comparison with in-situ position measurements.

With the following remarks:

- SAGE PROFILE v3.0 capabilities when it comes to trenching consideration, lateral buckling detection and pipe-in-pipe configuration is not covered by the present certificate (second phase of validation not performed)
- FUGRO validation report related to SAGE PROFILE v3.0 have not been reviewed by BV (third phase of validation not performed)

The results of this evaluation being satisfactory, within the above limitations and those specified in the technical report n°R1484/E&P12209-R-2015-01 Rev.0, the present certificate has been delivered for a period of three years from the date of issue, within the scope of the BUREAU VERITAS General Conditions of Service.

To whom it may concern,

Paris, 10th May 2016, Rev.0

For and on behalf of BUREAU VERITAS






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