INDEX OF REVISIONS

REV	DESCRIPTION AND / OR REVISED SHEETS
0	ORIGINAL THIS DOCUMENT SUPERSEDES AND REPLACES DOCUMENT I-ET-0000.00-6500-275-P9U-002 , REV. A.
A	REFERENCES REVISED
B	REFERENCES REVISED

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	01/12/2017	02/03/2018	11/03/2021						
DESIGN	EISE / EDR	EISE / EDR	EISE / EDR						
EXECUTION	BEJ8	BEJ8	BEJ8						
CHECK	SG5H	BF6J	C5DL						
APPROVAL	CLZ2	CLZ2	CLZ2						

TABLE OF CONTENTS

1 INTRODUCTION

1.1 General

This Technical Specification establishes the scope of work and minimum requirements for the Engineering and Construction related to the free-span correction activities.

The minimum scope of work for the engineering design activity includes:

- The design of the free-span supports;
- Free-span correction procedures;
- Offshore construction of free-span corrections using grout bags, mechanical supports, or other previously approved alternative technique to suppress existing free-spans.

This Technical Specification has its scope limited to describe free span supports design, procedures and operation of free span corrections. Regarding vessel requirements, it shall be noted that other requirements shall apply in accordance with others PETROBRAS technical specification.

This document is applicable to free spans rectification caused by soil imperfections or by pipeline crossings. In the last case the support installation shall be done before pipeline installation.

1.2 Abbreviations

The following abbreviations are applied in this document:

API	American Petroleum Institute
DGPS	Differential Global Positioning System
DNV	Det Norske Veritas
DP	Dynamic Positioning
FPSO	Floating Production Storage and Offloading
GB	Grout Bag

ISO	International Standards Organization
IBAMA	Instituto Brasileiro do Meio Ambiente (Brazilian Institute for Envonment)
MS	Mechanical Support
MSL	Mean Sea Level
PDOP	Position Dilution of Precision
ROV	Remotely Operated Vehicle
USBL	Ultra Short Base Line System
VRU	Vertical Reference Unit
WD	Water Depth
WT	Wall Thickness

1.3 Definitions

The following definitions are used for the purpose of this technical specification:

CONTRACTOR	The group or organization responsible for the design, manufacture, testing and delivery of the specified equipment and supply of services to perform the duties specified within the scope of this specification. This is used interchangeably with “Supplier” or “Manufacturer” or “Vendor”.
SHALL	Indicates a mandatory requirement
SHOULD	Indicates a preferred course of action
WORK	The entire project requirements as stated in the Purchase Order

2 REFERENCES

2.1 The revisions to be addopted for the referenced documentation shall be according to specific contract requirements**.**

2.2 Documents & Specifications

[1]	I-ET-0000.00-0000-940-P9U-002	ON BOTTOM ROUGHNESS AND FREE SPAN ASSESSMENT
[2]	I-ET-0000.00-0000-275-P9U-001	PIPELINE AND CABLE CROSSINGS
[3]	I-ET-0000.00-0000-940-P9U-003	THERMO-MECHANICAL DESIGN OF SUBSEA PIPELINES
[4]	PROJECT DESIGN REPORTS	PIPELINE DATASHEET PIPELINE DESIGN BASIS PIPELINE DESIGN ROUTE (OR AS-LAID IF AVAILABLE) PIPELINE GEOFISICAL DATA PIPELINE GEOTECNICAL DATA METOCEAN DATA PIPELINE ALIGNMENT SHEET PIPELINE POST-LAY SURVEY REPORTS PIPELINE FREE-SPAN ANALISYS PIPELINE CROSSING DESIGN PIPELINE THERMOMECHANICAL DESIGN
[5]	ET-3000.00-1521-600-PEK-001	PROJETO DE INTERFACES PARA OPERACOES COM ROV
[6]	ET-3000.00-1521-610-PAZ-002	FERRAMENTAS PARA OPERAÇÃO POR ROV
[7]	I-ET-0000.00-0000-250-P9U-001	SLEEPER FOR LATERAL BUCKLING INITIATION

2.3 Industry Standards

[8]	DNVGL-ST-F101	SUBMARINE PIPELINE SYSTEMS
[9]	DNVGL-RP-F105	FREE SPANNING PIPELINES
[10]	API-1111	DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF OFFSHORE HYDROCARBON PIPELINES

[11] ASME-B-31.4	PIPELINE TRANSPORTATION SYSTEMS FOR LIQUID HYDROCARBONS AND OTHER LIQUIDS
[12] ASME-B-31.4	GAS TRANSMISSION AND DISTRIBUTION PIPING SYSTEM
[13] ISO-9000	QUALITY MANAGEMENT SYSTEM
[14] AISC 89	MANUAL OF STEEL CONSTRUCTION
[15] N-1487	INSPEÇÃO EXTERNA – DUTOS SUBMARINOS
[16] N-1815	INSPEÇÃO SUBAQUATICA VISUAL
[17] N-2481	FOTOGRAFIA SUBAQUATICA
[18] N-381	EXECUÇÃO DE DESENHO E OUTROS DOCUMENTOS TÉCNICOS EM GERAL
[19] N-1710	CODIFICAÇÃO DE DOCUMENTOS TÉCNICOS DE ENGENHARIA
[20] N-2064	EMISSÃO E REVISÃO DE DOCUMENTOS DE PROJETO

3 CONTRACTOR'S EQUIPMENT

CONTRACTOR shall propose methods of seabed span correction and shall demonstrate the suitability of all proposed methods in accordance with the Installation License issued by IBAMA. CONTRACTOR shall ensure that there is no risk of damage to the pipelines.

3.1 Marine Vessel

3.1.1 General

CONTRACTOR shall provide an operational marine vessel capable of successfully performing the Work in accordance with the requirements of the contract. All vessels shall have valid class certify with a recognized classification society. The valid class shall cover all systems of importance for the safety of the operation. Contractor shall supply vessel details to PETROBRAS including the spread required to perform the work. Contractor shall provide details of previous experience with the methods and installation equipment to PETROBRAS for review prior to selection of the appropriate method.

The vessel shall be capable of locating the freespans identified by the post lay survey and holding station (DP system) over the work site for the duration of the freespan correction operation.

The vessel operations shall be designed to prevent damage to the spanning pipeline and other pipelines, umbilicals, flexibles, and subsea structures identified by the post-lay survey and the alignment sheets.

Further requirements for the vessels shall be as defined in DNVGL-ST-F101 and PETROBRAS technical specifications regarding support vessels.

3.1.2 Positioning Equipment

The surface positioning system shall be provided using two different systems. A primary system shall be the DGPS (with 100% redundancy), while the secondary

system shall be proposed by the Contractor for PETROBRAS approval. For underwater positioning the USBL system shall be used.

Differential Global Positioning System (DGPS):

The CONTRACTOR shall operate two DGPS providing 100% back-up in the event of system failure, as the method of establishing surface position. Preference shall be given to systems that receive differential corrections via satellite link and provide a multi-reference station capability with weighting given to the nearest station. The positioning accuracy shall be equal or less than ±1.5 meters.

In order to achieve this accuracy the following DGPS parameters shall be monitored in real time and operated within the ranges below (95% of the time):

- PDOP < 4
- Number of satellites above elevation mask > 6
- Arrival interval for differential corrections < 3 seconds

Acoustic – Ultra Short Base Line System (USBL)

For the survey, an USBL subsea positioning system with tracking transducer shall be used. This system shall be interfaced with the on-line electronic survey manager system and the surface positioning systems.

The CONTRACTOR shall supply all necessary equipment in order to have a fully operational USBL system interfaced to the on-line electronic survey manager system and the surface positioning systems. The installation of equipment shall comply with supplier’s recommended requirements, and special attention shall be given to the following:

- The hull mounted USBL transducers shall be located as to minimize disturbances from thrusters and machinery noise and/or air bubbles in the transmission channel or other acoustic transmitters;

- The USBL equipment shall be supplied with its own computer display unit and shall be capable of operating as a stand-alone system;
- The USBL transducer array shall be mounted on a long stem;
- The VRU shall be of a type recommended by the USBL system supplier;
- The system shall be capable of positioning at least nine transponders and/or responders;
- The system shall be supplied complete with, as a minimum, the supplier's recommended spares and replacement components.

The USBL equipment shall be subject to PETROBRAS approval.

The installation and calibration of the system shall provide an accuracy of better than 1% of the slant range or 10m, whichever is more restrictive.

The CONTRACTOR shall present prior mobilization the list of equipments with the technical specification and calculation of the overall accuracy of the USBL system for PETROBRAS approval. The CONTRACTOR shall advise PETROBRAS of the capability of the proposed positioning systems for the WORK with respect to accuracy and repeatability.

3.1.3 Cranes and Lifting Equipment

Cranes and lifting equipment including lifting gear, lifting appliances, slings, grommets, shackles and pad-eyes, shall meet applicable statutory requirements. Certificates for the equipment and materials, valid for the operations and conditions under which they will be used, shall be available on board for review.

All material and appurtenances shall be lowered to the seabed by a hoisting device (crane or winch). These devices shall be such that movements from the vessel are isolated from the equipment been lowered, in order to perform a smooth operation.

3.2 Equipment Testing and Surveys

All test programs, surveys, etc. carried out by Contractor to comply with this Specification shall be witnessed by PETROBRAS at its own discretion. If any equipment is deemed to be in unsatisfactory condition, it shall be repaired and submitted for re-inspection prior to mobilization. Any repairs required as a result of failing a test or survey shall be Contractor's responsibility.

Any vessels used for the span correction work shall fully comply with the relevant statutory and PETROBRAS requirements.

3.3 ROV Requirements

ROV onboard installation vessel shall be capable of successfully performing the work in accordance with the requirements of the contract. ROV shall be in compliance with at least the requirements of [6].

4 TECHNICAL REQUIREMENTS

4.1 Engineering Requirements

The maximum free spans allowed for the pipeline are defined on [4]. Where a pipeline exceeds the maximum allowed free-span length, CONTRACTOR shall determine the correction system, which is the most suitable for the case under analysis.

The size, shape and location of the correction devices shall be determined within the scope of the stress analysis calculations. Any system shall be approved by PETROBRAS before being applied. CONTRACTOR shall verify PIPELINE THERMOMECHANICAL DESIGN [3] to make decisions on type and details of correction method to be applied.

CONTRACTOR shall select the type of pipeline spans supports based on environmental loads, pipeline installation and operational loads and type of soil in the area considering also the long term settlement of the support. In case of using grout bags the scour effect shall be analyzed, if necessary.

CONTRACTOR shall study and define a methodology to suppress free-spans using the techniques defined below and shall issue a specification of the equipment required to perform such operation. A procedure to perform this operation shall also be supplied supported by the necessary calculations required when movement of the pipeline is necessary.

CONTRACTOR shall be responsible for establishing the methodology for free-span correction considering all techniques presented in this technical specification. Contractor can propose alternative methods not mentioned within this specification for free span correction. These alternative solutions shall be presented to PETROBRAS for approval prior its usage and shall be in accordance with the Installation License issued by IBAMA.

The pipeline is deemed supported once pipeline at support location is raised by a calculated height above seabed. This shall be such that the length of free span is

not increased, or if the length changes, that the length is still under the allowable limit (considering the activity of support installation and the position of pipeline after the new support is installed).

The methodology to be defined by CONTRACTOR shall only consider field proven methods. Final selection of the technique to be used for free-spans correction during operation should be made only after completing a detailed assessment of the number and location of free-spans to be corrected; this means that if a provisory selected method is used during pipelay to correct spans required for installation phase, it shall be replaced by the best methodology for the design life of pipeline.

4.2 Grout Bags

For grout bag support, the length of any supports perpendicular to the pipeline shall be, at least, three times the outer diameter of the pipeline on the pipe/grout bag interface.

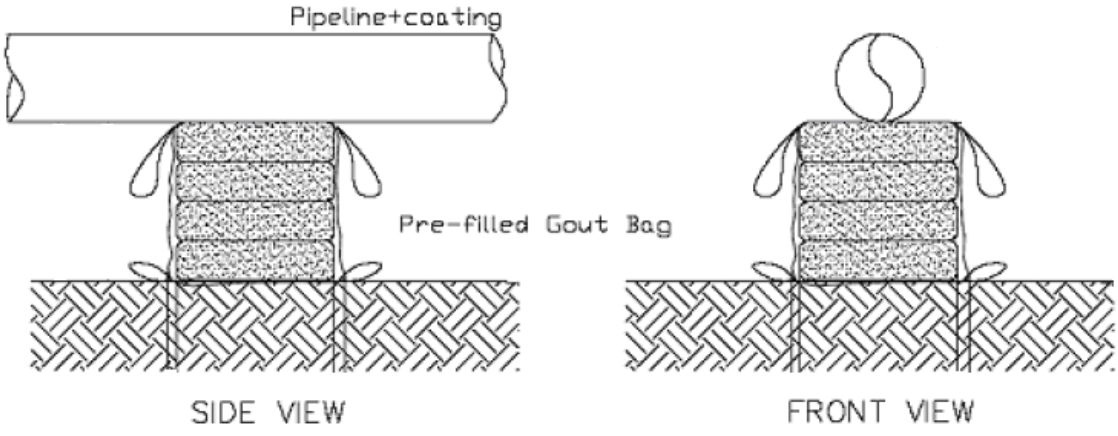

Figure 1: Basic details for grout bag correction

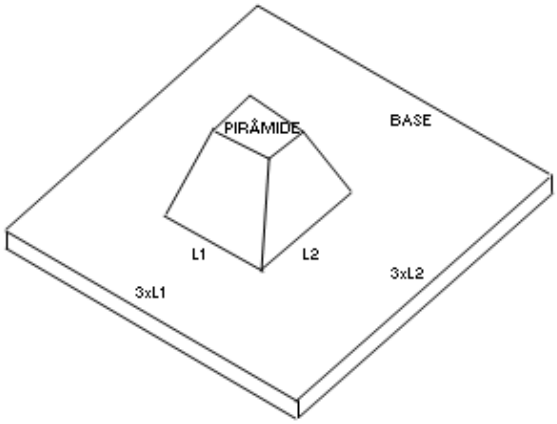

Figure 2: Basic details for grout bag span correction for higher height correction

The pipeline shall be restrained from lateral movement. CONTRACTOR shall propose a solution to guarantee that the pipe do not move laterally. This shall be approved by PETROBRAS.

For diverless operations, the grout bags shall be outfitted with ROV operated fittings and quick-release mechanisms. Written approval from PETROBRAS shall be granted for the grout bag type prior to use.

The grout mix design shall be selected by CONTRACTOR to provide at least 10 MPa compressive strength after 28 days curing time in seawater and shall be tested prior to offshore operations.

CONTRACTOR shall provide the bags, equipment, and labour for free span correction when results of the post-lay survey have shown the need for free span correction using grout bags.

Grout sacks with armoured concrete plate may be used by CONTRACTOR as an alternative method. In this case, small grout sacks shall be used only for final adjustment as presented below. Scour effect shall be analyzed when necessary.

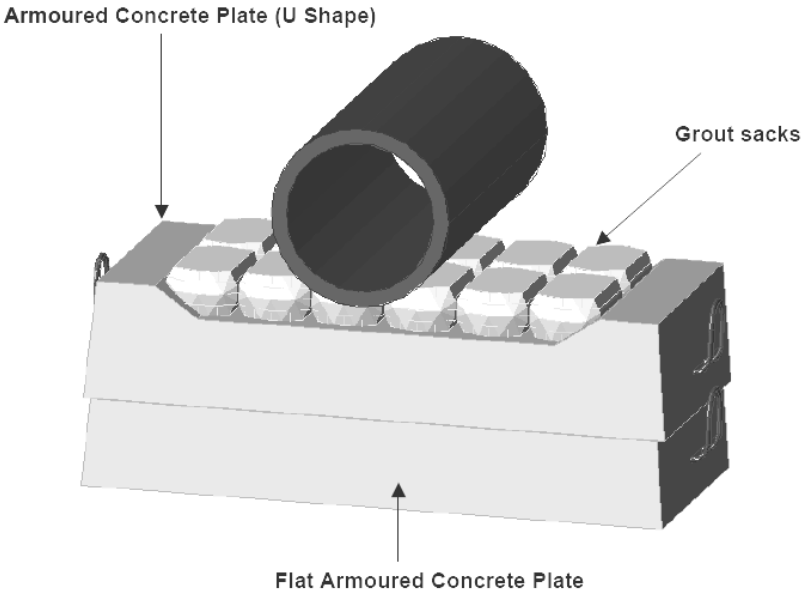

Figure 3: Grout sacks with armoured concrete plate

4.3 Mechanical Supports

The mechanical supports shall consist of three permanent elements, which remain on the pipe after installation:

- Self-closing clamp;
- Lifting frame;
- Two extensible legs;
- Mudmats (foots).

The mechanical support is also composed of two elements, used for support installation and retrieval to the surface:

- Hydraulic tools;
- Hydraulic Power Unit.

The mechanical support shall be deployed from a DP vessel with suitable crane capacity and shall achieve the following requirements:

- Provide vertical lift to pipe;

- Support an inclined pipe with cross slopes (including feet adjustment to grant full contact to soil);
- Be fully operated by ROV.

CONTRACTOR shall provide mechanical supports, materials, hydraulic system, equipment and labour for all free-span correction, as required.

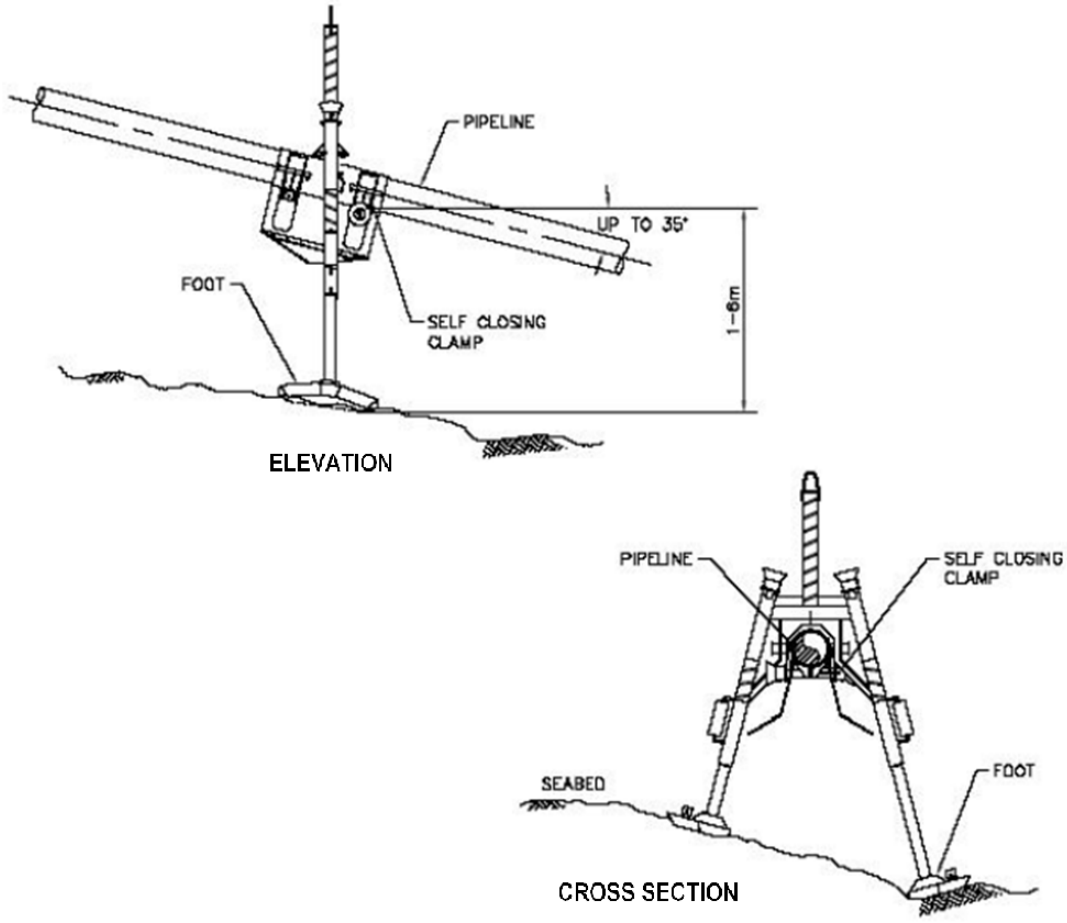

Figure 4: General arrangement of mechanical support

The mechanical support must be specified and fabricated by the CONTRACTOR, or by the defined sub-contractor, previously approved by PETROBRAS.

CONTRACTOR shall provide detailed design of mechanical support, considering, at least, but not restricted to:

- Mechanical Support Analysis;

- Shoes analysis;
- Cathodic Protection Analysis;
- Support-Soil Interaction;
- Lateral, vertical and axial loads.

The shoes of the mechanical support shall be such that it can be adjusted regarding longitudinal and lateral soil inclination. Shoes shall be totally in contact with soil. Written acceptance from PETROBRAS shall be granted for the Mechanical Support type prior to use.

All mechanisms on the support shall be in compliance with ROV intervention tools, and shall be in compliance with [5].

4.4 Mattress

Whenever freespans longer than the maximum admissible are previously identified on the on-bottom roughness analyses, mitigation by concrete mattress can be used. In that case, mattresses shall be installed prior to pipelaying.

CONTRACTOR shall design the mattress spread considering the laying corridor specified for the project, in order to assure that the pipeline will be laid over them. ROV shall monitore the TDP during laydown of pipeline on the mattresses.

Matresses tipicaly employ the inherent strength of concrete blocks linked together by an array of strong polypropylene rope. According to design requirements, the mattresses can be uni-directional or bi-directional. Uni-directional mattresses are often selected for use where soil conditions are weak and additional bearing is sought over that of multi-directional type mattresses. Polypropylene rope and cement shall be designed to withstand the design life of the project.

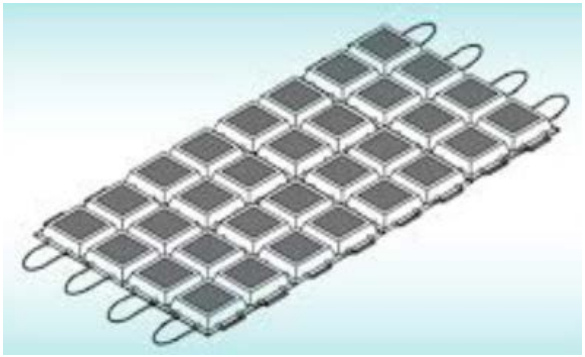

Figure 5: Bi-directional mattress

Figure 6: Uni-directional mattress

4.5 Sleepers

Sleepers are usually used for controlling lateral buckling behavior, and are secondary structures to be installed on the seabed purely for the purpose of supporting the pipeline. However, it is acceptable the adoption of sleepers with the purpose of free span correction. The pipeline crossing over sleepers shall be in compliance with all requirements established in Technical Specification of Pipeline and Cable Crossings [2].

Sleepers design, construction and installation shall be in accordance with [7], whenever applicable.

4.6 Alternative Methods

An alternative method, which could be adopted, may be lowering the pipeline by digging or trenching at a high point, according to the soil bearing capacity and free-span length.

When considering this solution CONTRACTOR shall consider the requirements of [3] and all environmental impacts due to the proposed solution.

4.7 Span Rectification Requirements

CONTRACTOR shall identify, from the list of free-spans provided by the PIPELINE POST-LAY SURVEY REPORTS [4] which free-spans require correction to meet operational requirements. Following agreement with PETROBRAS, the

CONTRACTOR shall then perform post pipe-lay span correction as required.

All post-lay span correction work shall be performed in the air-filled condition prior to pipeline cleaning/flooding.

CONTRACTOR shall propose the method to be adopted for free span corrections for PETROBRAS approval. For spans with soil inclination higher than 6 degree, it is recommended that CONTRACTOR verify the applicability of a pipeline lowering technique, soil rectification prior to pipelay or rock dump post pipelay. It is important to note that this methodology may also be applicable for soil inclination lower than 6 degree.

CONTRACTOR shall correct immediately all free spans identified during pipelay survey if identified spans length are longer than the Accepted Criteria for installation spans.

4.8 Surveys and Logs

Videos and logs of all span correction activities shall be kept and submitted to PETROBRAS after completion of the work. CONTRACTOR shall generate as-built drawings for all free-spans corrected.

The offshore survey activity shall be reported and stored in multimedia format. In order to perform this task an electronic survey management system shall be used. according to the specification for detailed design, procurement an installation of the specific project.

PETROBRAS' alignment sheets and data sheets shall be revised to produce the as-laid charts, updated and delivered to PETROBRAS.

5 DOCUMENTATION

All documents to be issued shall include in an introduction:

- Field description (if a Design Basis will not be issued by CONTRACTOR);
- Objective;
- Executive Summary.

All documents to be issued shall be in accordance with the last revision of PETROBRAS standards below:

- N-381 - Execução de Desenho e outros Documentos Técnicos em Geral;
- N-1710 - Codificação de Documentos Técnicos de Engenharia;
- N-2064 – Emissão e Revisão de Documentos de Projeto.

5.1 Design Reports and Procedures

CONTRACTOR shall develop and issue free-span design reports and correction procedures for PETROBRAS review, prior to CONTRACTOR mobilization to site.

These reports and procedures shall include, but not be limited to:

- Memory of calculations and drawings;
- Free-span correction procedures;
- Drawings and descriptions of the main free-span correction equipment.

The above mentioned procedure to be issued by CONTRACTOR, and reviewed by PETROBRAS, prior to CONTRACTOR's mobilization to site, shall include the following information:

1 OBJECTIVE

2 PIPELINE DATA

3 PROCEDURE DATA

5.2 Daily Log Report

CONTRACTOR shall prepare a daily log describing the activities performed during free-span correction operations.

Typically this will include, at least:

- Vessel / Sea state details, including wait-on-weather time;
- Span number;
- Span location;
- Summary of the work achieved;
- Span detailed data (length, clearance from seabed etc);
- Problem areas.

5.3 As-built

CONTRACTOR shall prepare an as-built report for span correction operations, on completing offshore activities.

As a minimum, the document shall include:

- Engineers reports and drawings;
- Survey results;
- Survey videos – before and after correction;
- As-built drawings of span correction areas;
- Log of activities.

All final documents shall be compiled into a CD/DVD-ROM with a navigator to be issued to PETROBRAS at the end of the work.

The survey performed by the ROV shall be recorded on digital means and handled to PETROBRAS on DVD. These videos shall be voice commented at the relevant frames and edited with explicative legends. The DVD shall have an introductory menu to guide to those relevant parties of inspection. The DVD menu shall have fast access link to all spans corrected by CONTRACTOR.