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	CLIENT: E & P		SHEET: 1 of 18
	JOB: PETROBRAS		
	AREA: PRODUCTION		
DP&T	TITLLE: **WEAR BUSHING FOR RISER UNIFIED DIVERLESS SUPPORT TUBES**		NP-1
			CENPES/PDIDP/TMEC

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1. INTRODUCTION

1.1. Scope of this Document

This Technical Specification establishes the main parameters for Riser Modular Support Tube regarding its wear issues describing the requirements for Wear Bushing and sliding parts design and their qualification wear tests (Figure 1).

1.2. SYSTEM DESCRIPTION

The Unified Diverless Support Tube (TSUDL) is a riser support system for rigid and flexible pipes (Figure 1). The design shall allow pull-in operations with minimal diver assistance. More details on the TSUDL may be found on document I-ET-3010.00-1519-140-P56-001. All requirements of I-ET-3010.00-1519-140-P56-001 are applicable for the Wear Bushing, since it is a component of the TSUDL.

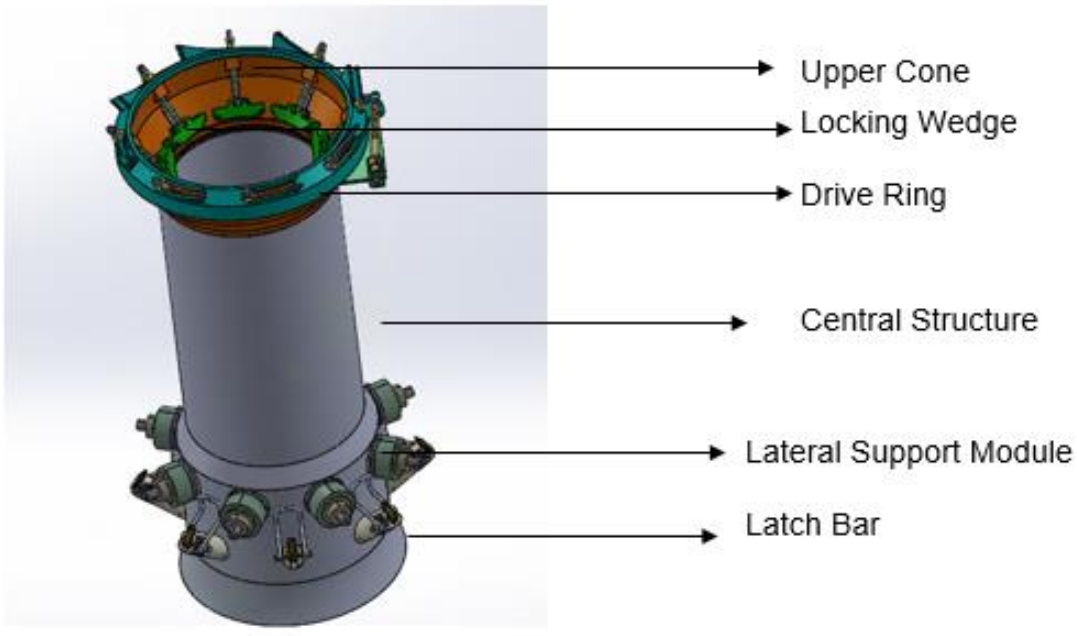

Figure 1 – Unified Diverless Support Tube Assembly main parts

1.2.1. Upper Cone

Component with mechanisms for locking the rigid riser top termination and supporting the riser top tension, connected to the Central Structure through assembly flange.

1.2.2. Locking Wedge

Forged sliding components responsible for bearing the rigid riser weight. On pull-in operations, it slides up due to direct contact with the Hang-Off Adaptor and returns for the bearing load position due to gravity and spring force. For pull-out operations, it slides up with the Drive Ring mechanism.

1.2.3. Drive Ring

Rotating component, connected to the top of the Upper Cone, providing an automatic and simultaneous retraction of all Locking Wedges.

1.2.4. Central Structure

Main cylindrical structural part that integrates all other TSUDL subcomponents for riser connection: Upper Cone welded on the upper part, Latch Bars and Lateral Support Modules on the lower part

1.2.5. Lateral Support Module

Sub-assembly responsible for providing lateral stabilization of the top riser termination, in which the riser shearing effort will be transmitted, which together with the reaction loads at the Upper Cone, will provide equilibrium forces to support the bending moments from the riser.

1.2.6. Latch Bar

Sliding component used to lock and secure Cap DL-SI on TSUDL for flexible riser connection.

1.2.7. Wear Bushing

Component responsible for providing wear protection to Locking Wedge and to the Top Cone against pull-in steel cable.

2. OBJECTIVE

The objective of this document is to define the Technical Specification (TS) to establish tests for homologation or qualification of the tribological aspects associated with the TSUDL for rigid KH (Keel-hauling) arising from component input slip in the support system during pull-in operations. The acceptance tests qualify the protection systems (Wear Bushing) of the Top Cone and the Locking Wedges and the sliding parts of the system in order to guarantee the integrity of the components during pull-in/pull-out operations, as well as in the prediction of eventual damages caused by relative movements between the other parts during the system operation. This TS also sets up design requirements for the Wear Bushing.

3. DEFINITIONS

3.1. General

For the purposes of this document, the following terms and definitions apply. Other terms and definitions can be found in reference documents and standards.

3.2. Definitions

Contractor	Company that runs the services or manufacturing contract of a SPU and hires the services for manufacturing of the Riser Modular Support Tube
Pull-in	Riser transfer operation from installation ship to the SPU
Pull-out	Riser removal operation.
Riser	A length of flexible or rigid pipe used to connect the subsea collecting/exporting system to the SPU.
Supplier	Company responsible for manufacturing the Riser Modular Support Tube

4. REFERENCE DOCUMENTS AND STANDARDS

Wear parts of the TSUDL design shall be in accordance with the following documents and standards in their latest revisions, unless otherwise indicated.

4.1. International Standards

ASTM E92 - Standard Test Method for Vickers Hardness of Metallic Materials;

ASTM E10 - Standard Test Method for Brinell Hardness of Metallic Materials;

ASTM E18 - Standard Test Methods for Rockwell Hardness of Metallic Materials;

ASTM E140 - Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness;

ASTM A 370 - Standard Test Methods for Mechanical Testing of Steels Products;

ISO 9001 – Quality management systems – Requirements.

Other Standards and test procedures will be defined in conjunction with PETROBRAS.

5. DOCUMENTATION

5.1. Bidding documentation

5.1.1. Contractor before proposal delivery shall inform conflicting data present in Petrobras drawings. If any problem is identified during manufacturing phase, the solution taken by Contractor SHALL NOT penalize Petrobras at any circumstance.

5.2. Manufacturing documentation

5.2.1. I-ET-3010.00-1519-140-P56-001 provides only preliminary conceptual drawings. Supplier shall detail the concept, including and not restricted to: structural analysis,

general geometric dimensioning and tolerancing considering surface coating thickness, pre-selected materials, manufacturing process or any other detailing issue for final manufacturing drawings.

5.2.2. Supplier shall generate its own drawings, according to its manufacturing methodology, and shall submit them to Contractor for analysis and approval.

5.2.3. Contractor shall be attentive to the revision of the manufacturing drawings provided by the Supplier. In case of doubts, ES/EISE/EDR shall be consulted through Petrobras representative.

5.2.4. The Supplier shall only start manufacturing the TSUDL after approval of manufacturing drawings by the Contractor.

6. DESIGN REQUIREMENT

6.1. Wear Bushing

6.1.1. The Wear Bushing design must be carried out in order to prevent wear damage in adjacent parts such as Locking Wedges, Top Tube and others parts. In addition, the Wear Bushing must retain its structural integrity for the number of cycles of pull-ins and pull-outs expected during the life cycle of the support system.

6.1.2. The Wear Bushing must meet the following minimum requirements, but not be limited to:

- Minimum service life of 25 years, performing at least 5 cyclical operations of pull-in and pull-out under wear conditions by the action of the continuous sliding of the pull-in/pull-out steel cable submerged in seawater with average temperatures by 25ºC;
- Withstand the stresses arising from the installation, mainly from the wear by sliding against the pull-in steel cable;
- Support the loads resulting from the installation, for a maximum tensile load corresponding to the 2500 m seawater depth, considering, among others, the compressive and tangential loads due to the steel pull-in cable contact;

- Consider the effects of operation in seawater, evaluating aspects of corrosion and cathodic protection, as well as deleterious effects common in these environments, such as hydrogen embrittlement;
- The wear bushing should preserve its own position and displacement during the launch and operation phases of the pipeline should not be permitted;
- Provide suitable protection against degradation effects for storage periods for at least six months exposed to environmental weather.

6.1.3. The Wear Bushing manufacturer must provide materials data book and fabrication traceability such as below listed properties, but not limited to:

- Materials yield strength (ASTM A 370);
- Materials ultimate strength (ASTM A 370);
- Materials Hardness according to ASTM E92, ASTM E10, ASTM E18, ASTM and/or E140 standards.
- The material and/or coating must have the appropriate hardness for its performance during its life time. In addition, the material cannot cause wear to the pull-in/pull-out steel cable in order to compromise its structural integrity.

6.1.4. Design above methodology as per supplier with all requirements must be submitted to Petrobras for comments and approval.

7. LABORATORY QUALIFICATION WEAR TEST

7.1. General

7.1.1. Wear tests by means of materials tribological behavior simulations must be carried out in laboratory conditions. The supplier must demonstrate that its methodology includes a laboratory test equivalence with the expected condition in the field for all sliding parts of the TSUDL assembly.

7.2. Wear Bushing Testing

7.2.1. Qualification wear test must be carried out in equivalent conditions experienced by the Wear Bushing during operation, that is, it must simulate the wear bushing contact versus the steel cable, considering conditions such as normal and tangential load, sliding speed, lubrication/cooling condition, total traveled distance, environment, temperature, etc.

7.2.2. The design requirements applicable to the Wear Bushing shall include, but not be limited to the following:

- Test procedure according to this Technical Specification;
- Detailed drawings of the wear apparatus and its parts;
- Certificates of calibration of the instruments and measuring devices used in the tests;
- All tests must consider statistical assumptions suitable for both planning and analysis of the results;
- Final report including all results, discussions and conclusions.

7.2.3. The supplier is responsible for carrying out the wear test and PETROBRAS will follow all procedures and may witness the execution. The following aspects will be:

- Verification and records of the methodologies used in the tests;
- Verification of results and prior suitability for using the Wear Bushing;

7.2.4. For TSUDL wear laboratory tests carried out in Brazil, the Contractor shall notify Petrobras, at least 10 (ten) calendar days in advance or as defined in the terms of the contract, the date when the TSUDL will be available for FAT. Or, for wear tests carried out abroad, the Contractor shall inform Petrobras at least 30 (thirty) calendar days in advance or as defined in the terms of the contract the date when the equipment will be available to be tested.

8. FULL SCALE WEAR TEST

8.1.1. The field test, carried out on the supplier's thickets, will consist of the passage of the pull-in cable against to the real scale Wear Bushing mounted on the system with equivalent wear normal load to those used in the pull-in/pull-out operations. So, the objective of this test is to reproduce a slid distance referred to, at least three operations with equivalent real scale wear normal loads. It will consist of the following points:

- Test procedure according to this Technical Specification;
- Detailed drawings of the wear apparatus and its parts;
- Certificates of calibration of the instruments and measuring devices used in the tests;
- Verification and records of the installation facilities of the Wear Bushing;
- Evaluation of the performance of the Wear Bushing during pull-in/pull-out steel cable real scale simulation.
- Verification of the appearance of damage such as grooves, cracks or rupture of the Wear Bushing and/or its fixing accessories;
- Evaluation of aspects related to safety, environment and health.
- All tests must consider statistical assumptions suitable for both planning and analysis of the results;
- Final report including all results, discussions and conclusions.

8.1.2. The supplier must send Petrobras a procedure for assembling and disassembling the protection system to be used for prior approval.

8.1.3. Any needs for special devices, specific tools to assist assembly and disassembly, must be submitted to prior approval by Petrobras and, if necessary, must be made available to Petrobras: operation and maintenance manuals, drawings, specific procedures and material list to your specifications.

8.1.4. The supplier is responsible for carrying out the wear test and PETROBRAS follows the execution. The following aspects will be:

- Verification and records of the methodologies used in the tests;
- Verification of results and prior suitability for using the Wear Bushing;

8.1.5. For TSUDL wear tests carried out in Brazil, the Contractor shall notify Petrobras, at least 10 (ten) calendar days in advance or as defined in the terms of the contract, the date when the TSUDL will be available for FAT. Or, wear tests carried out abroad, the Contractor shall inform Petrobras at least 30 (thirty) calendar days in advance or as defined in the terms of the contract the date when the equipment will be available to be tested.