PETROBRAS	**TECHNICAL SPECIFICATION**	No.: **I-ET-3010.00-1300-279-PPC-350**	
	CLIENT: E & P		SHEET: 1 of 44
	JOB: BELL MOUTH SYSTEM		
	AREA: ALL		
	TITLLE: **DIVERLESS BELL MOUTH STANDARD INTERFACE SUPPLY SPECIFICATION**		NP-1
			CENPES/PDIDP/ESUB/TDUT

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0	ORIGINAL
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D	STRUCTURAL CALCULATIONS REQUIREMENTS (CORROSION MARGIN, MATERIAL MODEL, DFF), STRESS-STRAIN TESTING, DESIGN REVIEW EVENT, STUD PRE-LOAD REQUIREMENTS, LATCH MECHANISM SPRING DESIGN, ANTIFOULING COATING SPECIFICATION, FAT THIRD-PARTY REPRESENTATIVE, BELLMOUTH WEIGHT REGISTER, FAT TEST STAND REQUIREMENTS
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	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	JUL 10, 2020	FEB 26,2021	SEP 03, 2021	MAR 28, 2022	JUL 29, 2022	DEC 12, 2022			
DESIGN	CENPES	CENPES	CENPES	CENPES	CENPES	CENPES			
EXECUTION	BERK	BERK	BERK	BERK	UPVT	CMC1			
CHECK	CJLZ	CMC1	CMC1	CMC1	CMC1	CX4H			
APPROVAL	BERL	BERL	BERL	BERL	BERK	BERK			

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1. INTRODUCTION

This Technical Specification establishes the main parameters for BELL MOUTHS supplying and describes the criteria for design, manufacturing, inspection, and acceptance tests.

2. OBJECTIVE

The objective of this document is to define the Technical Specification (TS) for the supplying of DIVERLESS BELL MOUTHS WITH STANDARD INTERFACE – BSDL-SI model manufactured in carbon steel for equipping I-TUBE of 32”, 46” and 48” nominal diameter, providing protection for umbilicals and flexible risers.

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

3.2.1. Bell Mouth

BELL MOUTH is a device used for supporting and locking bend stiffeners for flexible risers.

3.2.2. Bend Stiffener

Bend Stiffeners are conically shaped polyurethane mouldings designed to add local stiffness to a riser, flowline, cable or umbilical

3.2.3. Buyer

PETRÓLEO BRASILEIRO S.A. – PETROBRAS Where referred to in this Specification, it means both the Company itself and its employees authorized to Communicate with Seller

3.2.4. Cap DL-SI

Bend Stiffener´s metallic component that provides alignment of this equipment inside the BELL MOUTH, containing an interface geometry for the locking system (Latch Bars).

3.2.5. Dimensional Gauge

Mechanical gauge to verify BELL MOUTH inner diameters after Riser Balcony Integration

3.2.6. Diverless Bell Mouth with Standard Interface – BSDL-SI

It is a BELL MOUTH designed to allow pull-in and pull-out (if Hydraulic Actuation System is requested) operations with little diver assistance, and with a Bend Stiffener standard interface geometry with previous Buyer Bellmouth designs.

3.2.7. DFT

Dry film thickness: the thickness of a coating as measured above the substrate.

3.2.8. Dummy Cap

Mechanical part that replaces the Bend Stiffener's Cap DL-SI and its docking process into the BELL MOUTH during the FAT.

3.2.9. FPSO

Floating Production Storage and Offloading.

3.2.10. Handlers

Handlers are sets including a lever and a cam that are used in the latch bar locking mechanisms.

3.2.11. Hydraulic Actuator System

Simple action hydraulic actuator, which can be installed on BSDL-SI Round Blocks, providing means for remote control to unlock the Latch Bar for pull-out operations.

3.2.12. NDT

Non-Destructive Testing

3.2.13. Pull-in

Riser transfer operation from pipe laying vessel to the FPSO.

3.2.14. Pull-out

Riser removal operation.

3.2.15. Riser

A length of flexible or rigid pipeline used to connect the subsea collecting/exporting system to the FPSO.

3.2.16. Seller

Company responsible for the supply of one FPSO, including the manufacturing of the BELL MOUTH.

3.2.17. Test Record Sheet – TRS

Test Record Sheet is a document used to register each step of BELL MOUTH tests.

3.2.18. Testing Stand

Testing Stand is a test bench used to simulate the fastening of the BELL MOUTH on the I-Tube.

4. REFERENCE DOCUMENTS AND STANDARDS

BELL MOUTH's manufacturing shall be in accordance with the following documents and standards in their latest revisions, unless otherwise indicated.

4.1. International Standards

API RP 2X - Recommended Practice for Ultrasonic and Magnetic Examination of Offshore

ASTM A370 – Standard Tests Methods and Definitions for Mechanical Testing of Steel Products;

ASTM A517 – Standard Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered;

ASTM A578 – Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications;

ASTM B841 – Standard Specification for Electrodeposited Coatings of Zinc Nickel Alloy Deposits

AWS D1.1 – American Welding Society Structural Welding Code;

DNV-RP-0034 – Steel forgings for subsea applications

DNV-RP-B401 – Cathodic protection design

DNV-RP-C203 – Fatigue design of offshore steel structures

EN 473 – Qualification and certification of non-destructive testing personnel – general principles;

EN 15800 – Cylindrical helical springs made of round wire. Quality specifications for cold coiled compression springs;

ISO 13628-7 – Petroleum and natural gas industries — Design and operation of subsea production systems — Part 7

ISO 8501 – Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness;

ISO 8504 – Preparation of steel substrates before application of paints and related products – Surface preparation methods;

ISO 9001 – Quality management systems – Requirements;

ISO 9712 – Non-destructive testing – Qualification and certification of NDT personnel;

ISO/IEC 17024 – Conformity assessment – General requirements for bodies operating certification of persons;

ISO/IEC 17020 – Conformity assessment – Requirements for the operation of various types of bodies performing inspection;

ISO GUIDE 65 – General Requirements for Bodies Operating Product Certification Systems;

SSP-SP1 – Solvent Cleaning;

SSPC-SP10 – Near-White Metal Blast Cleaning.

4.2. Brazilian Standards

ABENDI NA 018 – “Qualificação e certificação de pessoas em teste por pontos” (Qualification and certification of persons for 8hemical spot testing);

ABNT NBR 14842 – “Critérios para a qualificação e certificação de inspetores de soldagem” (Criteria for welding inspector qualification and certification);

ABNT NBR 15218 – “Critérios para qualificação e certificação de inspetores de pintura industrial” (Industrial paint inspectors – Rules for qualification and certification);

ABNT NBR 16278 – “Inspeção de fabricação — Qualificação e certificação de pessoas para o setor de petróleo e gás” (Manufacturing inspection — Qualification and certification of personnel for the oil and gas sector);

ABNT NBR NM ISO 9712 – “Ensaios não destrutivos – Qualificação e certificação de pessoal” (Non-destructive testing – Personnel qualification and certification);

PETROBRAS N-133 – “Soldagem”

PETROBRAS N-1859 – “Qualificação de Consumíveis de Soldagem” (Qualification of Welding Consumables);

PETROBRAS N-2301 – “Elaboração da documentação técnica de soldagem” (English – Elaboration of technical documents for welding);

PETROBRAS N-2941 – “Competências pessoas em atividades de inspeção” (Personal competencies for inspection activities)

PETROBRAS PP-5EN-00008 – “Ensaio não destrutivo – qualificação de pessoal” (Non-destructive testing – personnel qualification).

5. DOCUMENTATION

5.1. Bidding documentation

5.1.1. Seller before proposal delivery shall inform conflicting data present in Buyer drawings. If any problem is identified during manufacturing phase, the solution taken by Seller SHALL follow Article 12 of the agreement.

5.2. Manufacturing documentation

5.2.1. The BELLMOUTH final design is Seller responsibility, in which the Basic drawings supplied by Buyer shall be evaluated by structural calculation required in 6.

5.2.2. Final Basic drawing revision I-LI-3010.00-1300-279-PPC-350 will be issued by Buyer in notice to proceed.

5.2.3. Seller shall generate its own drawings, according to its design and manufacturing methodology, and shall submit them to Buyer for analysis and approval.

5.2.4. Seller shall be attentive to the revision of the manufacturing drawings. In case of doubts, Buyer representative shall be consulted.

5.2.5. Seller shall only start manufacturing the BELL MOUTH after approval of manufacturing drawings by Buyer.

5.2.6. The present document is referred for a full mechanical locking/unlocking mechanism BSDL-SI. If the Hydraulic Actuator System is applied to the present project, its Technical Specification shall be considered for an integrated design with BSDL-SI.

5.3. Dummy Cap drawing

5.3.1. Defines the Dummy Cap to be used in factory acceptance test.

5.3.2. I-DE-3010.00-1300-279-P56-373 – specifies the Dummy Cap to the BSDL-SI model.

6. STRUCTURAL CALCULATION

6.1. General

6.1.1. Seller shall perform a structural assessment (static loads and fatigue) considering the loads generated by Seller following the methodology defined by I-ET-3010.00-1500-274-PLR-001 (RISER TOP INTERFACE LOADS ANALYSIS)

6.1.2. If the calculations indicate the need of structural changes, the design modification requirement shall only be implemented after Buyer approval.

6.2. Finite Element Analysis -FEA

6.2.1. Finite element analysis shall be used to establish static structural and fatigue performance of the Bellmouth.

6.2.2. The finite element analysis shall be modeled using contact formulation at least on the interaction between the Bellmouth and the adjacent structures: I-Tube and CapDL-SI.

6.2.2.1. The contact interaction between the Bellmouth and the Cap DL-SI shall be modeled in order to correctly represent the localized stresses due to these contacts

6.2.2.2. The contact interaction between the Bellmouth and the I-Tube shall be modeled, including the studs pre-load with appropriate accuracy (see section 9.4), in order to model the prying effect and the consequence on these elements for static and fatigue calculations.

6.2.3. Care shall be exercised in the finite element analysis to ensure that appropriate element types, mesh refinement, element aspect ratio/distortion and boundary conditions are used.

6.2.4. Applied boundary conditions shall be clearly indicated in model sketches and/or in finite element plots.

6.2.5. Mesh sensitivity analysis shall be performed to ensure that accurate results are predicted. Mesh density convergence checks shall be presented in the reports.

6.2.6. The sensitivity of the calculation model and the parameters utilized in the model shall be examined.

6.2.7. Surfaces of equipment structural elements in contact with salt water and therefore vulnerable to corrosion must be reduced in thickness by 3.75mm on each face for structural strength calculations.

6.2.8. Stress-strain curve with strain hardening shall be considered for non-linear structural calculation.

6.3. Reference Standards for Structural calculation

6.3.1. Seller shall consider the design requirements from ISO 13628-7 (Petroleum and natural gas industries — Design and operation of subsea production systems — Part 7: Completion/workover riser systems) for static loads analysis.

6.3.2. Seller shall consider the design requirements from DNV-RP-C203 (Fatigue design of offshore steel structures) for fatigue analysis.

6.3.2.1. The calculated life shall exceed the specified design life with Design Fatigue Factor (DFF) of 10, assuming no inspections required during the design life (non-inspectable structure).

6.3.2.2. The structure is to be considered a fatigue sensitive component and designed accordingly. Material toughness, welding procedures, and inspection criteria shall be selected to insure meeting the required fatigue life.

6.3.2.3. All welds that require grinding to meet the required life shall be clearly detailed on SUPLIER's drawings. The root and crown surfaces shall merge smoothly with the adjoining base metal without the undercut exceeding 0.5mm (0.02 in). Final grinding marks shall be transverse to the weld axis.

6.4. FEA Methods to Evaluate Protection Against Progressive Collapse

6.4.1.1. Methods for protection against progressive collapse from repeated loading are found on internationally recognized design codes. Seller shall follow the recommended procedure of the respective selected codes for the verification of the Bellmouth.

6.4.1.2. For a FE elastic analysis, the sum of primary plus secondary stresses shall be less than the respective allowable value defined on the selected code. Note that if all requirements for protection against plastic collapse are met in an elastic FE analysis with all stresses categorized as primary then the load is safe regarding progressive collapse. In the context of verification of protection against progressive collapse by means of elastic analysis, it is considered acceptable the use of stress linearization as per section 5.5.6 of ASME Section VIII, Division 2.

6.4.1.3. However, if elastic-plastic analysis results are used, then an assessment method compatible with such type of analysis shall be employed instead (e.g. see section 5.5.7 of ref. ASME Section VIII, Division 2).

6.5. FEA Documentation

6.5.1. The analysis report shall be sufficiently detailed to allow for independent verification and approval by a third party, Buyer, Seller, either based on review of the documentation, or using independent analyses. The documentation shall include at least description of:

- Purpose of the analysis;
- Failure criteria;
- Geometry model and reference to drawings used to create the model;
- Boundary conditions;
- Element types;
- Element mesh;
- Material models and properties;
- Loads and load sequence;
- Analysis approach;
- Application of safety factors;
- Mesh convergence study results;
- Analysis results;
- Sensitivity analysis;
- Discussion of results;

- Conclusions;
- Any other performed verification.

6.5.2. The third-party activities are Seller responsibility

6.5.3. The final version of the document specified hereinabove shall be approved by Seller and Buyer before the start of the BSDL-SI manufacturing.

7. MODIFICATIONS AND ADJUSTMENTS

7.1.1. Seller shall not machine the latch bars to force the contact with the Dummy Cap. The shape and angles of the latch bars shall not be changed from the dimensions and tolerances shown in the manufacturing drawings approved by the Buyer.

7.1.2. Seller can implement small changes in the BELL MOUTH's design to make it appropriate to its manufacturing process or to correct small non-conformities. In this case, Seller shall submit a written document to Buyer describing the problem and the proposed solutions.

7.1.3. The changes or corrections mentioned in 7.1.2 will only be implemented after Seller's and Buyer's approval.

7.1.4. A Design review event, with representatives from Buyer and Seller, shall be held before the start of the BSDL-SI manufacturing. The final version of the FEA documentation shall be issued before this event

7.1.4.1. To avoid major changes on the detailed design performed by Seller at a later stage, it is highly recommended for the Seller to schedule preliminary meetings with Buyer before the Design Review event.

7.1.5. The document approved shall be included in the data book.

8. BELL MOUTH IDENTIFICATION AND TRACEABILITY

8.1. Bell Mouth Identification

8.1.1. All BELLMOUTHS shall be identified regarding their numbering of riser-slot position on Balcony arrangement according to ref. I-ET-3000.00-1200-940-P4X-001. Markings shall be performed in three points (top and sides of support), in an indelible form (linear weld bead) and painted in a contrasting color. Characters shall be visible and identifiable by divers and by ROV. The choice of the positions for these markings shall be sent to Buyer approval.

8.1.2. Each sector shall be marked on two different places: external cylindrical surface and Bellmouth Cone.

8.1.3. The minimum paint height shall be equal to 200 mm (two hundred millimeters)

8.2. Traceability

8.2.1. Codification and traceability procedures shall be in accordance with item 7.5.3 of ISO 9001 plus the following requirements:

8.2.2. Alphanumeric codes for traceability shall be punctured in materials using low stress punches.

8.2.3. Each equipment shall receive a unique codification in order to allow tracing back its respective inspection and tests reports.

9. MATERIALS AND COMPONENTS

9.1. General

9.1.1. Seller shall provide material certificates of raw materials used in BELL MOUTH manufacturing to be included in the data book, as in item 19 of this specification.

9.2. Ferrous Materials

9.2.1. Ferrous materials used to manufacture the cylindrical body, latch bars and springs shall be certified by a classification society

9.3. Forged Materials

9.3.1. As a minimum forging requirement shall meet Classification Society Rules for hull construction and DNV-RP-0034 steel forging classes - SFC 3 with following modifications and additional information:

- Min. Yield Strength (0.2 % Offset): 355 MPa
- Min. Tensile Strength: 455 MPa
- Elongation in 2 in. or 50 mm, min 20%
- Charpy V-Notch Impact test temperature: -20°C
- Charpy V-Notch Minimum Average Absorbed Energy: 50 J (set of 3 samples)
- Charpy V-Notch Minimum Individual Absorbed Energy: 34 J.

9.4. Studs

9.4.1. Studs for BSDL-SI assembly to the I-Tube (I-DE-3010.00-1300-279-PPC-330) shall comply with the Technical Specification I-ET-3000.00-1500-251-PEK-001.

9.4.2. The flanges make-up shall be made with a pre-load stress of at least 50% of stud's material SMYS, using a hydraulic tensioner for a proper pre-load accuracy.

9.5. Spring

9.5.1. Seller shall be attentive to the material defined in spring's drawing I-DE-3010.00-1300-279-PPC-310.

9.5.1.1. The Beryllium Copper Alloy (C17410 HT - TH04) is selected as a biocide material to avoid marine growth. For a proper operation of this material characteristic, the spring shall be insulated from the impressed current cathodic protection from the FPSO (see 13).

9.5.1.2. The spring electrical insulation shall be made by the selection of nonconductor material for the Structural Washer (I-DE-3010.00-1300-279-PPC-309). And for the Centralizer (I-DE-3010.00-1300-279-PPC-311).

9.5.2. I-DE-3010.00-1300-279-PPC-310 table presents a preliminary spring design that was obtained by mechanical compression spring theory, and the spring geometric properties may be modified to achieve the design requirements. The values indicated on the table represents the following conditions:

9.5.2.1. F1: Latch mechanism pre-load, which corresponds to the “Locked” condition presented on drawing I-DE-3010.00-1300-279-P56-350 sheet 2/2.

9.5.2.2. L1: Corresponding spring length for F1 condition, which may depend on spring free length (L) and geometric/material properties (see Figure 1).

9.5.2.3. F2: spring compression corresponding to the Latch Bar necessary stroke for CapDL-SI/Dummy Cap automatic connection.

9.5.2.4. L2: Corresponding spring length for F2 condition, which may depend on spring free length (L) and geometric/material properties (see Figure 1).

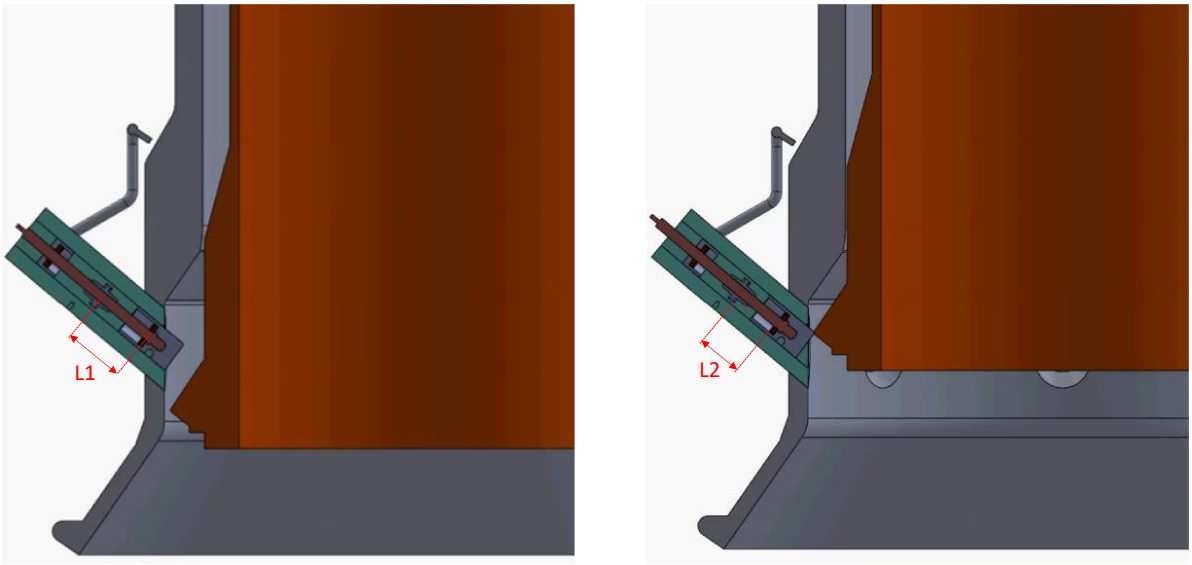


Figure 1 – Latch Mechanism spring design conditions (L1 and L2).

9.5.3. The spring shall be designed with sufficient pre-load to shear any marine growth inside the Round Block’s square hole. This capability is obtained by F1; thus, this condition shall be the main requirement to be achieved.

9.5.4. The mechanism return force shall be similar to the original design

9.5.4.1. Spring Stiffness (k) shall be similar to the original design

9.5.4.2. Please note that the spring stiffness by design may be inferred by k=(F2-F1)/(L2-L1).

9.5.5. The F1 and F2 shall be verified by tests, with tolerances as per EN 15800.

9.6. Thermally Pretreated Steels

9.6.1. Parts manufactured with thermally pretreated steels may need heat treatment after welding and/or machining for ensure that its mechanical properties will remain

unaltered. Seller shall contact the supplier of the steel to specify the appropriate heat treatment.

9.7. Materials Testing

9.7.1. Seller shall perform a tensile test to obtain the stress-strain diagram for all the structural metallic materials. Results shall be included in the data book, as in item 19 of this specification.

9.7.2. When using thermally pretreated steel in the manufacturing of latch bars, if the material suffer any manufacturing process that can alter its mechanical properties (such as, but not limited to, cutting with blowtorch), the manufacturer must ensure that the properties of the finished material remain similar to the properties of raw material.

9.7.3. Seller shall manufacture an additional latch bar by batch of steel plate used. This additional latch bar shall be heat-treated along with the latch bars that will be used in the assembly of the BELL MOUTH.

9.7.4. Destructive testing shall be performed on this additional latch bar to estimate the mechanical properties of the remaining latch bars. The results shall meet the contractual specifications and shall be part of Data Book, as in section 19 of this specification.

10. PROCEDURE AND PERSONNEL QUALIFICATION

10.1. Requirements for personnel qualification and certification

10.1.1. Seller shall meet the following personnel qualification and certification requirements:

10.1.1.1. **Inspectors for non-destructive testing** – in order to perform visual, liquid penetrant, magnetic particle, radiographic, ultrasonic, and eddy current testing in Brazil, qualification and certification shall be according to the Brazilian System of Personnel Qualification and Certification in NDT – ABENDI, in conformity with standard ABNT NBR NM ISO 9712. For manufacturing executed abroad, qualification and certification shall be according to that established above or by independent international entities that meet requirements in standard ISO/IEC 17024 and that operate in conformity with standards ISO 9712 or EN 473;

10.1.1.2. **Welding inspectors** – in order to perform welding inspection in Brazil, qualification and certification shall be by the Brazilian System of Welding Inspector Qualification and Certification (FBTS), according to standard ABNT NBR 14842. For level 2 inspectors, this FBTS qualification and certification shall be in the main applicable standard. For manufacturing executed abroad, qualification and certification shall be according to that established above or by independent international entities that meet requirements in standard ISO/IEC 17024, and for level 2 inspectors, in the main applicable standard as well.

10.1.1.3. **Customer fabrication inspectors** – in order to perform customer fabrication inspection in Brazil, in the modalities presented below, qualification and certification shall be by PETROBRAS/ETM-CORP/ST/SEQUI-ETCM, according to ABNT NBR 16278. For manufacturing executed abroad, qualification and

certification shall be according to that established above or by independent international entities that meet requirements in standard ISO/IEC 17024. For manufacturing executed abroad is acceptable also, as an alternate route for ISO/IEC 17024, that the inspection shall be performed by Inspection Bodies accredited by National Accreditation Bodies that are members of IAF-International Accreditation Forum. The Inspection Bodies shall be accredited in accordance with ISO/IEC 17020 type A, for the same Field of Inspection (e.g.: Boilers and pressure vessels) and Methods and Procedures (e.g.: ASME VI–I - Rules for the construction of pressure vessels; ASME/ANSI B 31.1 and 31.3, Power and process piping and associated systems, materials and components) considered for the customer inspection to be carried out.

- piping accessories;
- metallic equipment, structures, boilers and piping;
- mechanics;
- oil drilling and production;
- offshore mooring and loading;
- flexible pipes and umbilicals.

10.1.1.4. **Coating inspectors** – in order to perform coating inspection in Brazil, qualification and certification shall be the Brazilian System for Qualification and Certification of Personnel on Corrosion and Protection (ABRACO), according to ABNT NBR 15218. For manufacturing executed abroad, qualification and certification shall be according to that established above or by independent international entities that meet requirements in standard ISO/IEC 17024;

10.1.2. Regarding qualification of welders and welding operators, Seller shall meet the following directives:

10.1.2.1. Welders and welding operators shall be qualified by a level 2 welding inspector, according to the equipment project standard. If the qualification standard of these professionals is not foreseen in the specifications, standard ASME Section IX shall be used for this purpose. Tackers are not allowed to be used, even when qualified according to technical standards;

10.1.2.2. For activities in Brazil, welders or welding operators who have been performing welding activities without interruption for over three months, and were qualified for other jobs at Buyer, can be used, so long as they present qualification records according to Petrobras N-2301, accompanied by their respective individual certificates (original documents), properly approved by a qualified welding inspector and endorsed by Buyer Inspection of previous jobs;

10.1.3. Seller shall present to Inspection, before beginning of activities, the list of operators and inspectors qualified to perform and inspect the manufacturing.

10.2. Requirements for Procedure Qualification

10.2.1. Seller shall qualify the following procedures for non-destructive testing, before the beginning of activities:

a) Ultrasonic Testing;
b) Liquid Penetrant Testing;
c) Magnetic Particles Testing;

d) Visual Testing;

10.2.2. Procedures presented above shall be qualified according to corresponding standards and certified by a level 3 inspector, with qualification and certification established in 10.1.1.

10.2.3. Welding procedures shall be qualified and certified before the beginning of activities, according to the following specifications:

10.2.3.1. For activities rendered in Brazil by a level 2 welding inspector, qualified and certified in the main standard applicable. Qualification and certification shall be by the Brazilian System of Welding Personnel Qualification and Certification – FBTS, according to standard ABNT NBR 14842, or;

10.2.3.2. Welding activities rendered abroad by qualified and certified welding inspectors, shall be also in the main applicable standard by independent international entities that meet requirements in standard ISO/IEC 17024.

11. WELDING

11.1. General

11.1.1. All welds shall be in accordance with American Welding Society (AWS) Structural Welding Code - Steel, AWS D1.1.

11.2. Welding Procedure Specification Requirements

11.2.1. WPS shall meet, at least, Classification Society Rules for hull construction and [36] with following modifications and additional information:

- Min. Yield Strength (0.2 % Offset): 355 MPa
- Min. Tensile Strength: 455 MPa
- Elongation in 2 in. or 50 mm, min 20%
- Charpy V-Notch Impact test temperature: -20°C
- Charpy V-Notch Minimum Average Absorbed Energy: 50 J (set of 3 samples)
- Charpy V-Notch Minimum Individual Absorbed Energy: 34 J
- The maximum hardness in the HAZ and weld metal is 325 HV10 for C-Mn and low alloy steels.

11.3. Personal Qualification

11.3.1. The welders and welding procedures shall be qualified and certified in accordance with item 10 of this technical specification.

11.3.2. Qualification of NDT Inspectors shall be according to AWS D1.1, API RP 2X and N-2941.

11.4. Welding Consumables

11.4.1. Consumables used in Brazil shall be certified by the Product Certification Body (OCP) as a Conformity Assessment Body (OAC) accredited by INMETRO under

the *Sistema Brasileiro de Avaliação de Conformidade* (SBAC), according to Petrobras N-1859. When used abroad, they shall be certified by an OCP accredited by INMETRO or a foreign OCP that complies with ISO GUIDE 65. In this case, the consumable trademark does not comprise an essential variable in the qualified procedures. In case the welding consumables are not certified by the OCP, the change in consumable trademark, even if this does not modify its classification, results in the requalification of the welding procedure.

11.4.2. Once the consumables with suffix G are not certifiable by OCP, their use shall be limited to situations in which there is no specific classification to optimize a characteristic required for welding of a given material. If their use is required, the Welding Procedure Specification (WPS) and Welding Procedure Qualification Record (RQPS) shall clearly contain: trademark, specified chemical composition of deposited weld metal, specific toughness requirements (testing temperature and impact energy), and post-weld condition (as welded or treated). In addition, it shall have lot control, according to AWS A5.01 Schedule J. The welding of that consumable shall be used only with previous approval of Seller. The respective lot certificates shall present the values specified and accepted by Seller. For use of consumables generically classified (which means, equivalent to suffix “G”) with specification different from AWS, such as, for example, of European standard (EN) or standard ISO, (only allowed when provided in the design standard of equipment), the same requirements described herein for suffix “G” consumables of specification AWS shall be met.

11.5. Heat treatment

11.5.1. Heat treatment for stress relief shall be performed in the BELL MOUTH structural body after all welds have been performed and before the inner diameters machining in order to avoid the structure ovalization and to improve the material fracture toughness.

11.5.2. Post weld heat treatment exemptions may be proposed by Seller by submitting to Buyer approval a fracture mechanics assessment in as-welded joint based on BS 7910 at the minimum temperature application and considering the stress levels and the minimum detectable flaw size. Not inspectable weld locations as the root of partial penetration weld of round block to central structure shall consider crack length over the entire weld bead.

11.6. Weld design

11.6.1. Full Penetration weld, with qualified procedure, shall be considered for every structural weld. Appropriate NDT shall be performed in every joints.

11.6.2. All welds shall be documented and included on the analysis requested in 6.

12. MANUFACTURING INSPECTION

12.1. General

12.1.1. Seller shall maintain a fabrication inspector during manufacturing process of the BELL MOUTH.

12.1.2. All inspection records and results shall be included in the data book.

12.1.3. Inspections shall be performed in accordance with specific procedures and shall include at least the activities listed in 12.2 to 12.9.

12.2. Inspection and Tests Plan – ITP

12.2.1. Seller shall define the extent of his participation in the monitoring of inspections and factory tests through an Inspection and Test Plan – ITP – to be prepared and submitted by Seller.

12.2.2. Seller shall send the ITP for Buyer approval respecting the contractual terms.

12.2.3. The ITP is a document within the Seller's Quality Plan that follows the standards set by quality management standards, which shall contains at least:

a. A description of activities of the manufacturing process, including those carried out in sub-suppliers, indicating the types and extent of exams, tests or checks to be performed during the manufacturing process;

b. Identification of intervention type that will be performed by Seller's inspection representative throughout the manufacturing cycle (document verification, monitoring point, observation point and holding point;

c. Indication of procedures, technical specifications and standards for each activity;

d. Acceptance criteria for all features and quality requirements of each activity, including activities carried out at sub-supplier facilities;

e. Identification and preparation of quality records, citing the record type applicable to each activity.

12.3. Preparation and cutting

12.3.1. Verify if parts to be cut are identified in accordance with item 8.2 of this Technical Specification.

12.3.2. Verify if materials certificates correspond to the specified ones in the drawings.

12.3.3. Verify if parts dimensions are in accordance with drawings.

12.4. Pre-assembly

12.4.1. Verify if traceability of the parts is in accordance with item 8.2 of this specification and belong to the same assembly.

12.5. Nondestructive tests

12.5.1. All procedures and personnel used in NDT shall be qualified and certified in accordance with item 10 of this technical specification.

12.5.2. Visual inspection - All welds shall be inspected in 100% (both sides) of their extension to check aspect and continuity.

12.5.3. Liquid penetrant inspection – All welds shall be inspected in 100% of their extension.

12.5.4. Magnetic particle inspection - Shall be performed in union welds: cylindrical body vs. conical structure, cylindrical body vs. Round Block and cylindrical body vs. flange.

12.5.5. Ultrasonic inspection – Shall be performed in 100% of the welded joints performed by full penetration and in 100% of the plate used to manufacture the latch bars, before cutting them.

12.5.6. Surface finishing of all latch bars shall be in accordance with the drawings. The tests records shall be part of Data Book, as in item 19 of this specification.

12.5.7. Hardness shall be verified on all latch bars and shall be 32HC maximum. The tests records shall be part of Data Book, as in item 19 of this specification.

12.6. Latch Bar tensile and Impact Tests

12.6.1. One latch bar shall be used to prepare 2 (two) samples for the tensile tests and 2 (two) samples for the impact tests. See Figure 2 and ASTM A370 for samples dimensions.

12.6.2. The samples shall be extracted after latch bars heat-treatment.

12.6.3. A Test Inspection and Certification Society (TIC-Society) shall certify the tests results.

12.6.4. The results shall be part of Data Book, as in item 19 of this specification.

12.6.5. Tensile Tests

12.6.5.1. The yield strength, tensile strength, stretching and area reduction shall be obtained by tensile test.

12.6.5.2. The yield strength shall be 500 (five hundred) MPa minimum.

12.6.6. Impact Test

12.6.6.1. Charpy tests shall be performed at -10 ºC (minus ten degrees Celsius).

12.6.6.2. The result shall be 27 (twenty-seven) Joules minimum.

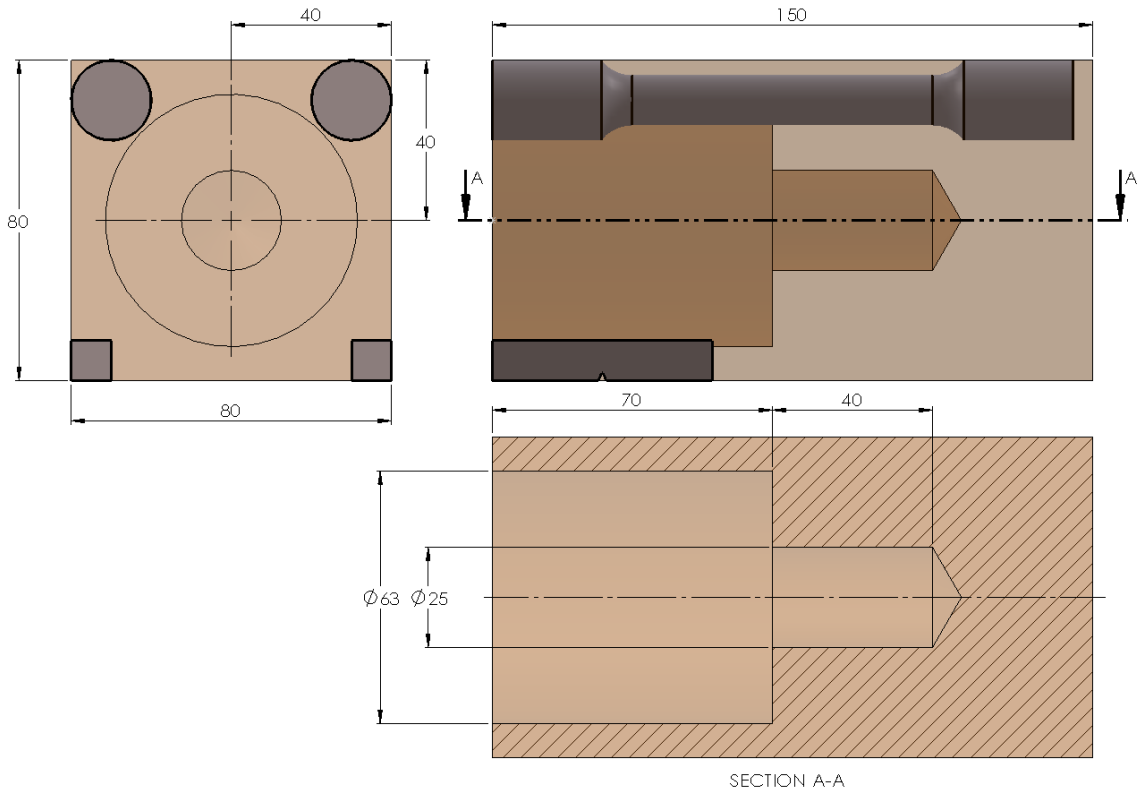


Figure 2 - Position for extraction of tensile and impact tests samples.

12.7. Dimensional

12.7.1. Verify if dimensions are in accordance with the drawings.

12.7.2. Buyer highlights that the correct pre-assembly of the moving parts (as presented drawing I-DE-3010.00-1300-279-P56-350) is critical for the mechanism performance.

12.7.2.1. Seller may consider to manufacturing a template to achieve the required distance prior to assembly the moving parts on the Round Block.

12.7.3. The Bellmouth inner diameters shall be measured at least in the vertical P1 to P4 positions, as shown in the Figure 3 below.

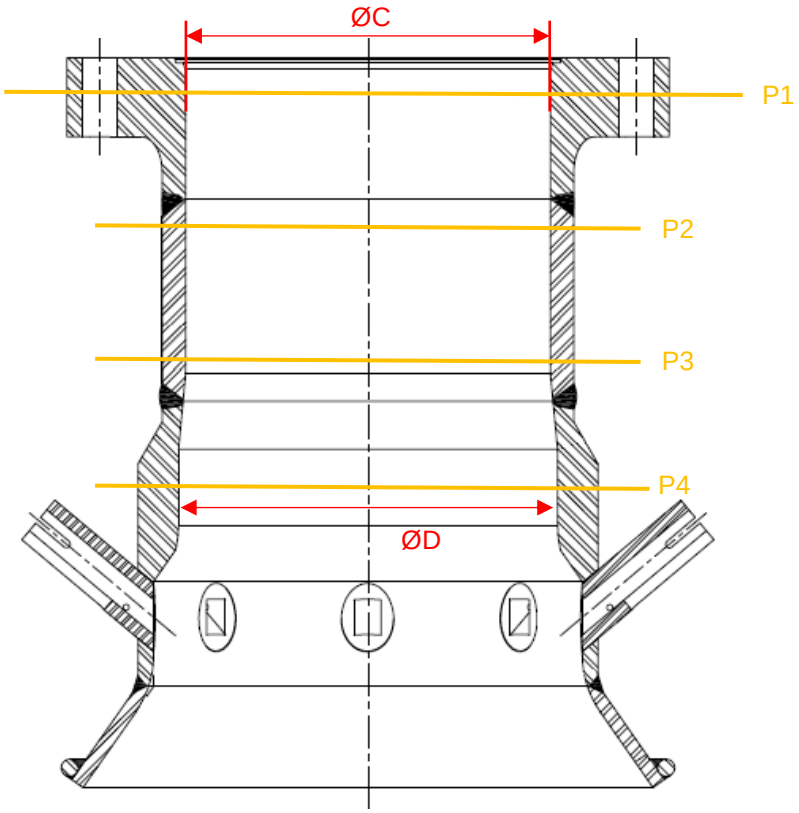


Figure 3 - Vertical positions for internal diameters measurements.

12.7.3.1. At least, in each vertical position, four measurements of the inner diameters shall be made, with angles of 45 degrees between them, as shown in the Figure 4 below.

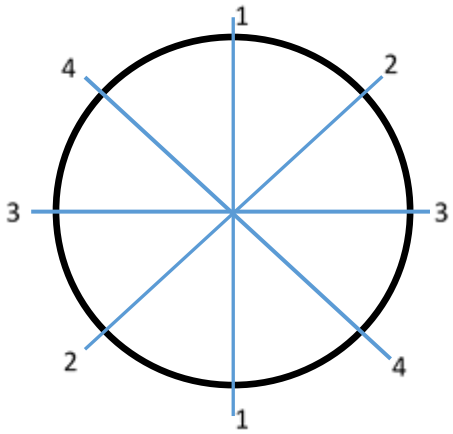


Figure 4 - Angular positions for internal diameter C measurements.

12.7.4. In addition to inner diameters, the respective thicknesses in vertical positions P2 and P3 shall be measured.

12.7.5. In total, at least 32 measurements of inner diameters and 16 measurements of thicknesses must be made (8 in each vertical position P2 and P3).

12.8. Equipment weight verification

12.8.1. Verify the weight of each individual BELLMOUTH. The measure shall be registered on the data book, as in item 19 of this specification

12.9. Availability of documents for inspection

12.9.1. Seller shall keep available for the inspectors at all times the ITP, procedures, technical standards and other documents necessary to perform the inspection and interpretation of results.

12.10. Nonconformities

12.10.1. All non-conformities records shall be part of the data book, as in item 19 of this specification.

13. CATHODIC PROTECTION

13.1. General

13.1.1. The BELL MOUTH cathodic protection is provided by the electrical contact with the I-tube structure, which is supplied by the impressed current from the FPSO.

13.1.1.1. To assure the electrical contact between the BELL MOUTH and the I-Tube, the flange contact surfaces from both sides shall not be painted.

13.1.2. All electrical cables shoes shall have a brazed connection to the cable.

13.1.3. Seller shall consider bolt loosening prevention with proven and reliable methods due to dynamic loads imposed by sea waves and current on supports and cable connections, complying with the requirements of I-DE-3010.00-270-P56-028.

13.1.4. Electrical continuity between all components must be tested after assembly according to DNV-RP-B401.

14. COATING

14.1. General

14.1.1. Seller shall observe that parts whose drawings present the indication "DO NOT PAINT" are not to be either coated or electrically isolated.

14.1.2. Although not indicated on all the cable connections on the drawings, all the surfaces where the cables shoes are assembled shall be free of coating to assure the electrical contact.

14.1.3. Coating procedure shall comply with item 14.2 or coating manufacturer specification. In case of divergence, coating manufacturer specification shall be used, observing the thickness specification for each layer and final thickness.

14.1.4. Seller shall consider different top coat colors for fixed components (e.g. Bellmouth main body) and for moving parts (e.g. Latch bars) to make a contrast in order to achieve an easier visualization for ROV operation. The selected color scheme shall be approved by Buyer

14.1.4.1. Similar color scheme may be used for Bellmouth identification, as requested on 8.1.

14.2. Finishing and anti-fouling coating

14.2.1. Surface preparation

14.2.1.1. All surfaces shall be free of oil, grease and salt contamination before blasting. Abrasive blast clean to Sa 2 ½ ISO 8501 or SSPC-SP10. If oxidation occur between blasting and coating application, the surface shall be re-blasted to the specified visual standard. Surface defects revealed by the blast cleaning process shall be ground or corrected in the appropriate manner.

14.2.1.2. Anchor profile: A sharp, angular surface profile of 50-75 microns (2-3 mils) is recommended.

14.2.1.3. Salt Contamination: Surface salts concentration (e.g. Chloride deposits) shall be less than 70 milligrams/m^2 (or 7 micrograms/cm^2) prior to coating.

14.2.1.4. All surfaces to be coated shall be clean, dry and free of contamination. Prior to coating application all surfaces shall be assessed and treated in accordance with ISO 8504. Oil or grease shall be removed in accordance with SSPC-SP1 solvent cleaning.

14.2.2. Epoxy Coating

14.2.2.1. Apply two coats of High Abrasion Resistant Aluminum Epoxy Coating Cured with Polyamine, with a minimum dry film thickness of 125 microns per coat, using airless spray gun. Interval from one coat to the next shall be at least 7 (seven) hours or at most 14 (fourteen) days.

14.2.3. Sealant Coating

14.2.3.1. Seven (7) hours to fourteen (14) days after applying second coat of primer, apply one coat of intermediate bi-component coal tar free epoxy, with a minimum dry film thickness of 100 microns, using airless spray gun. Interval from one coat to the next shall be at least 8 hours.

14.2.4. Antifouling Coating

14.2.4.1. Apply two coats of copper free, self polishing copolymer (SPC) antifouling coating, for static condition in maximum current of 3 knots, with a minimum dry film thickness of 125 microns per coat, using airless spray gun.

14.3. Final thickness

14.3.1. The maximum thickness of the coating after application of finishing and antifouling layers shall not exceed 0.6 mm.

14.3.1.1. Special attention for the tolerances indicated on drawing I-DE-3010.00-1300-279-P56-350 (ØA, ØB and ØC) as it is a critical dimension for pull-in operation, as it defines the clearance between the BELL MOUTH and the CAP DL-SI. If

necessary, Seller can propose to Buyer modifications to the coating scheme presented on 13.2 to achieve the required inner diameter tolerances.

14.3.2. Coating thickness shall be included as a verification item on ITP.

14.4. Final Coating

14.4.1. The BELL MOUTH shall be delivered with the coating free of defects.

14.4.1.1. Inspection by Holiday Detector is mandatory.

14.4.2. For the FAT, BELL MOUTH shall be coated with the last layer applied (antifouling). If any BELL MOUTH component is not in its final coating, such fact shall be reported, the tests shall be postponed and the coating of the parts shall be finished.

14.4.3. After FAT, coating shall be touched up to remove any risks and defects caused by the test. Final Thickness shall not exceed that required in item 14.3 of this specification.

14.4.3.1. If necessary, the coating shall be touched up only in parts that do not require disassembly of the locking mechanisms. If Seller need to disassemble the locking mechanisms, the BELL MOUTH shall be retested.

14.5. Anti-friction coat

14.5.1. Apply one coat of PTFE finishing with a minimum dry film thickness of 25 microns in parts whose drawings specify this type of coating.

15. DUMMY CAP

15.1. General

15.1.1. Only one Dummy Cap may be manufactured for each diameter of BELL MOUTH.

16. FACTORY ACCEPTANCE TESTS – FAT

16.1. General

16.1.1. The BELL MOUTHS shall be individually tested to verify their mechanical functioning (simulation of the PULL-IN, operation of the latch bars handling mechanisms and PULL-OUT).

16.1.2. The tests shall be performed with the Dummy Cap manufactured in accordance with drawings supplied by Buyer as listed in item 5.3.

16.1.3. An independent third-party representative shall witness and approve all tests. The third-party activities are Seller responsibility.

16.1.4. All tests are Seller's responsibility.

16.1.5. A member of Quality Control department of the Seller shall witness all tests and is responsible for registering the tests results and filling out the TRS. This member is also responsible for reporting any deviation occurred during the tests.

16.1.6. A Seller representative shall witness and approval all tests.

16.1.7. Buyer reserves the right to send a representative to monitor the tests. This representative will not have the responsibility of approving or rejecting the tests.

16.1.7.1. For BELL MOUTHS manufactured in Brazil, Seller shall notify Buyer, at least 10 (ten) calendar days in advance or as defined in the terms of the contract, the date when the BELL MOUTH will be available for FAT.

16.1.7.2. For BELL MOUTHS manufactured abroad, Seller shall inform Buyer, 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.

16.1.8. During all testing, the BELL MOUTHS shall be transported on pallets and is not acceptable to transport the BELL MOUTHS in direct contact with the fork of the forklift.

16.1.9. Tests performed with the BELL MOUTH inverted (cone facing up) are unacceptable.

16.1.10. Tests shall be performed by lifting the Dummy Cap into a fasten and secured BELL MOUTH on test stand. It is not allowed to perform the tests with the Dummy Cap fixed and moving the BELL MOUTH.

16.1.11. A load cell shall be installed between the lifting cable and the Dummy Cap in order to measure the load required to overcome the force exerted by the springs. This measurement shall be reported in the TRS and sent to Buyer for information.

16.2. FAT Procedure

16.2.1. Seller shall submit a FAT Procedure for Buyer analysis and approval.

16.2.2. This procedure shall observe at least the requirements in ANNEX A.

16.3. FAT Infrastructure

16.3.1. Seller shall provide the entire infrastructure necessary to perform the tests.

16.3.2. The infrastructure necessary to perform the test shall contain, at least, the following items:

16.3.2.1. One Dummy Cap for each set of BELL MOUTHS of same diameter that will be tested. The Dummy Cap diameter must be compatible with the BELL MOUTH that will be tested;

16.3.2.2. One wire rope with suitable mechanical resistance to lift up Dummy Cap and BSDL-SI;

16.3.2.3. Shackles, with suitable mechanical resistance to lift up Dummy Cap and BSDL-SI;

16.3.2.4. Load cell to measure the force needed to overcome the springs;

16.3.2.5. Synthetic cables (ropes) for guiding the Dummy Cap.

16.3.2.6. A lifting device, that can be a crane, an overhead crane, etc., capable of suspending the Dummy Cap with a speed between 2 and 4 m/min;

16.3.2.7. A test stand containing a fastening device specifically designed to secure the BELL MOUTH so the cylindrical body is plumb. The lower conical part of the BELL MOUTH shall be at an appropriate distance from the floor so the Dummy Cap can be positioned below it and the handling mechanisms of the latch bars can be operated manually.

16.3.2.8. A walkway and a guardrail shall be available for secure access to the mechanism of the latch bars.

16.3.2.9. An example of a test stand (16.3.2.7) with appropriate walkway (16.3.2.8) is presented on Figure 5:

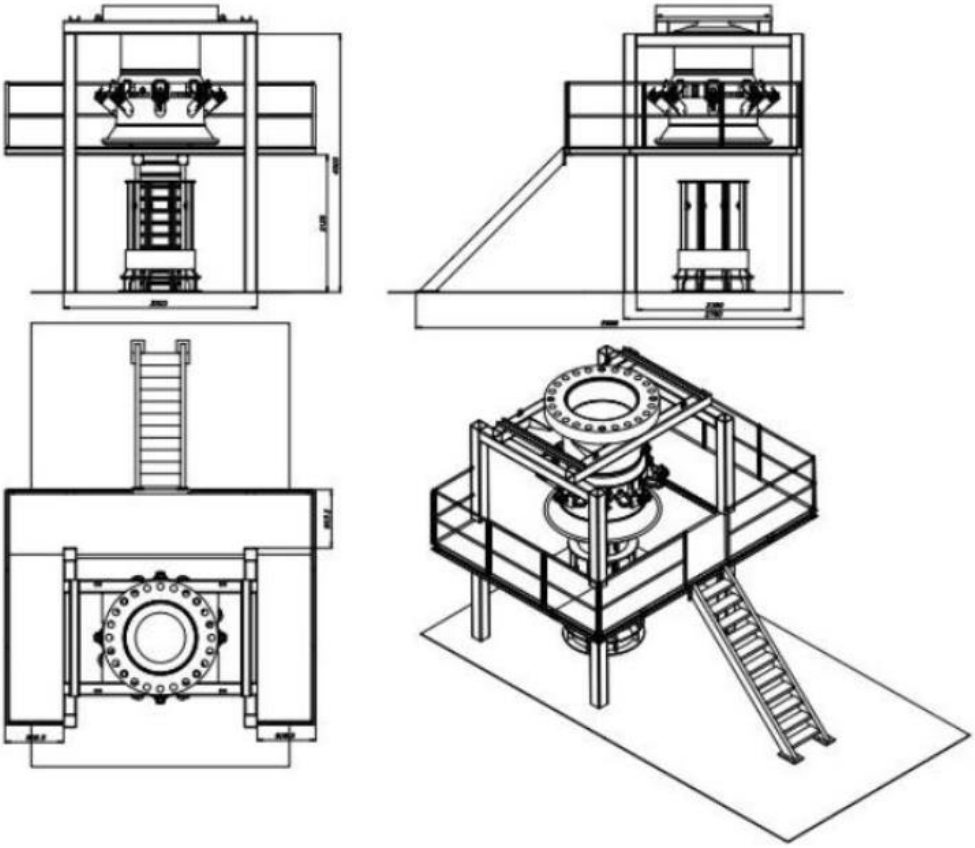


Figure 5 – Example of Test Stand with appropriate walkway

16.3.2.10. A four-wire sensing micro-ohmmeter, with suitable resolution for measuring values around 0.1 Ω.

16.4. FAT Results

16.4.1. The FAT results shall be reported in the Test Report Sheet – TRS. A TRS model and instructions on how to fill it out is provided in ANNEX B.

16.4.2. The Seller's Quality Control member shall issue one report by BELL MOUTH set tested stating one of two results: Accepted or Rejected.

16.4.3. The BELL MOUTH with status “Send to Repair” shall be repaired and retested. It will only be considered “Accepted” after correction of all non-conformities and after passing through all tests.

16.4.4. Any repair made in the BELL MOUTH invalidates all tests performed until that moment.

16.4.5. The BELL MOUTH Rejected shall be discarded and a new BELL MOUTH with the same characteristics shall be manufactured.

16.4.5.1. In this case, the new BELL MOUTH shall receive a new serial number.

16.4.6. The TRS of rejected and discarded BELL MOUTHS shall be included in the set of data book of approved ones.

16.4.7. In case of any BELL MOUTH performance problems, Seller shall contact Buyer, and it reserves the right to send a representative in order to assist in the evaluation of non-conformities.

17. PROTECTION AND PACKING

17.1. General

17.1.1. BELL MOUTHS shall be delivered packed to ensure the integrity of the parts, in special of the locking devices mechanisms.

17.1.2. The packing shall avoid the ingress of any debris in the Round Block Mechanism.

18. RECOMMENDATIONS FOR BELLMOUTH AND FPSO INTEGRATION

18.1. General

18.1.1. Seller shall define the Bellmouth preservation recommendations (e.g., UV exposure restriction, packing condition, or any other issue) in order to assure any quality loss due to inappropriate storage on shipyard.

18.1.1.1. For an appropriate preservation recommendation, Seller shall consider the main FPSO schedule milestones related to the Bellmouth integration.

18.1.1.2. The milestones shall include, but not limited to, the expected time between the FAT and Bellmouth integration with the Riser Balcony and the end of drydock condition.

18.1.2. In principle, no coating touch-up is allowed during the drydock phase.

18.1.2.1. This disallowance is due to the importance of the DFT tolerances for the Bellmouth compatibility with the CapDL-SI, particularly on the Bellmouth inner diameters.

18.1.2.2. If by any eventuality it is considered that a Bellmouth coating must be repaired, Seller shall consider the requirements on 14.4 and the repair procedure shall be approved by Buyer.

18.1.3. The Bellmouth shall be assembled on I-Tubes with a hydraulic tensioner, with the required pre-load required on 9.4.2, that shall be validated by structural calculation with the requirements of 6.2.2.2.

18.1.4. The cable connections integrity (cathodic protection transmission for moving parts) shall be verified after the Bellmouth assembly on the Riser Balcony and before the end of drydock. If necessary, these connections shall be repaired by the Seller.

18.2. I-Tube Integration dimensional gauge

18.2.1. The integration dimensional gauge should be used in shipyard to verify the main BSDL-SI´s dimensions and flange make-up misalignment after its integration to the FPSO Riser Balcony and the subsequent compatibility with the CAP DL-SI that will be provided by the Riser supplier.

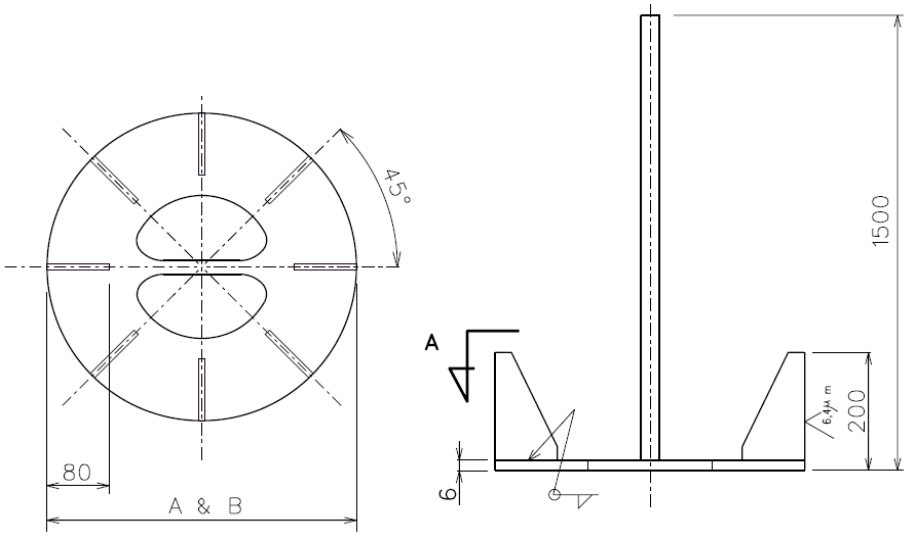
18.2.2. The dimensional gauge should be used to assure that no unexpected event occurred to the BSDL-SI between the FAT and the FPSO integration (e.g., disallowed coating touch up or damage during BSDL-SI's shipment).

18.2.3. The dimensional gauge may be produced with a lightweight material (e.g., aluminum) for a better handling.

18.2.4. Buyer reserves the right to require the use of the dimensional gauge on shipyard whenever it considers to be necessary.

18.2.5. Figure 6 shows a preliminary design for the dimensional gauge, which can be used to inspect the respective inner diameters shown in Figure 7

18.2.5.1. Information: The dimensional gauge diameters do not correspond to neither CapDL-SI (I-DE-3010.00-1300-279-P56-375) nor Dummy Cap (I-DE-3010.00-1300-279-P56-373). These dimensions also assure the compatibility with the Bend Stiffener design from previous Buyer Bellmouth designs (see definition 3.2.6), whose further details are not necessary for BSDL-SI supply.



BSDL-SI model	ØA	ØB

32”	675,5/675,0 mm	711,5/711,0 mm
46”	1025,5/1025,0 mm	1061,5/1061,0 mm
48”	1075,5/1075,0 mm	1111,5/1111,0 mm

Figure 6 – Dimensional gauge preliminary design

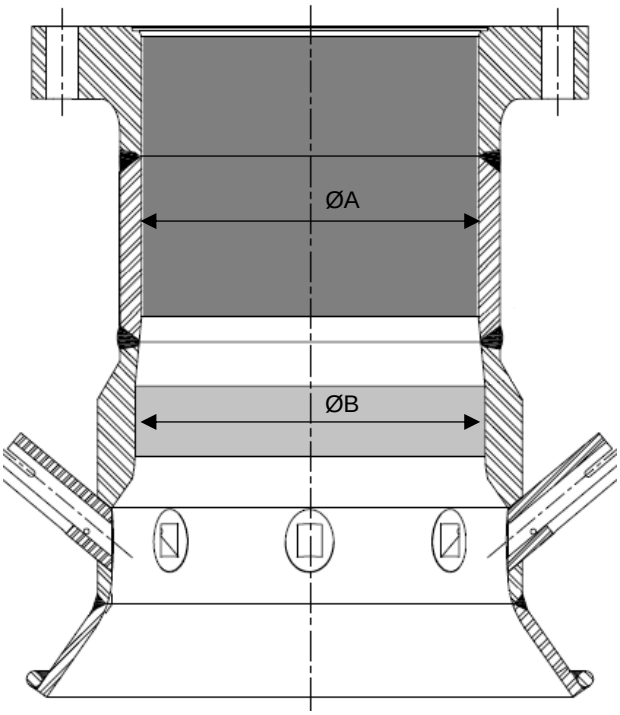


Figure 7 – BSDL-SI’s inner diameter to be inspected with the Dimensional Gauge

19. BELLMOUTH OPERATION MANUAL

19.1. General

19.1.1. Seller shall issue an operation manual for the Bellmouth pull-in and pull-out operations and for equipment maintenance.

19.1.2. The operation manual shall consider the Hydraulic Actuator System it is applied to the present project.

20. DATA BOOK

20.1. General

20.1.1. For BELL MOUTHs manufactured in Brazil, the Data Book shall be emitted in Portuguese language, unless otherwise requested. For BELL MOUTHs manufactured abroad, the Data Book must be emitted in the language defined by the FPSO contract.

20.2. Minimum Content

20.2.1. Seller shall issue a Data Book of the products, in order to allow traceability of all parts, containing at least the following items:

20.2.1.1. Certificate of conformity with time of guarantee according to RM (including elements of fixation).

20.2.1.2. Certificate of raw materials and tests according to this specification and project standards;

20.2.1.3. Stress-strain curves for all structural metallic materials.

20.2.1.4. Records of heat treatment and tests according to this specification and project standards.

20.2.1.5. Records of Non-Destructive Examinations according to this specification and project standards.

20.2.1.6. Measured weight of each manufactured BELLMOUTH.

20.2.1.7. Records of FAT according to this specification and project standards.

20.2.1.8. Qualifications of the welding process and welders according to this specification and project standards.

20.2.1.9. Records of dimensional inspection according to this specification and project standards.

20.2.1.10. Inspection and Tests Plan (ITP) approved by Costumer.

20.2.1.11. Identification and inclusion of all reports issued by Seller inspection, concerning the released products.

20.2.1.12. Identification and inclusion of non-conformities of the manufacturing process / sub supplier and the corrective actions taken concerning the released products.

20.2.1.13. Drawings of set containing traceability of all critical components of the project, reported in the ITP.

20.3. Distribution

20.3.1. The Seller shall deliver hard copies along with a copy in electronic media of the Data Book to Buyer.

ANNEX A

Factory Acceptance Test Procedure Minimum Requirements, Sequence and Acceptance Criteria.

1. Introduction

In the procedure elaborated by the Seller, the tests description shall contain at least the following information.

2. General

The tests described below are meant to evaluate if the latch bars and the locking mechanisms are working properly.

Every BSDL-SI shall be tested.

The tests shall be performed using a template called Dummy Cap, Figure 1 , plumb lifted.

For the Dummy Cap tests and the latch bars mechanism tests, the inner parts of the BSDL-SI as well as the set of locking mechanisms shall be fully coated, including the anti-fouling layer.

As outlined in section 5.2.4 of I-ET-3010.00-1300-279-PPC-350 C Hydraulic Actuator system may be attached on BSDL-SI for a locking/unlocking mechanism. If it is applied to the present project, the procedure presented below shall be modified/combined with the FAT requirements on the Hydraulic Actuator Technical Specification.

The BSDL-SI shall be securely fastened to the test stand structure, preventing its movement in the longitudinal and transversal directions, as well as the rotation relative to its main axis.

Seller shall evaluate and correct any unsafety conditions on all testing procedures.

Before the beginning of the tests, Seller shall inspect and, if necessary, clean all the Bellmouths to assure that all the structures are free of any debris that may affect the mechanism function.

IMPORTANT: As defined in section 16.4.3 of I-ET-3010.00-1300-279-PPC-350 if deviations occur that lead to some repair in BELL MOUTH, the tests shall be restarted from the beginning (**Ra1** test). Repairs invalidate the tests performed previously.

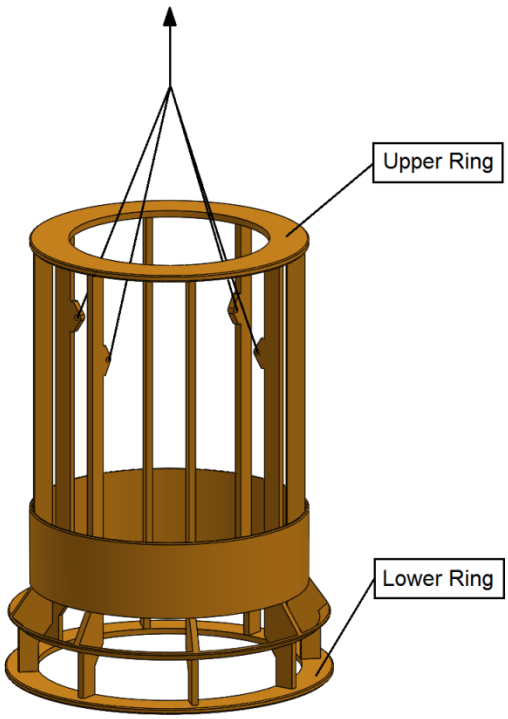


Figure 1 – Dummy Cap – Template for the BSDL-SI tests.

3. BSDL internal diameters verification

3.1. Objective

This verification aims to evaluate the BSDL-SI internal diameters, through a drift pipe testing.

The Dummy Cap upper and lower rings diameters are slightly bigger than the Cap DL-SI ones, and are used as templates, as shown in Figure 1.

The upper ring verifies the BSDL-SI internal main interface surface compatibility with the Cap DL-SI that will be furnished by the riser supplier.

The lower ring verifies the concentricity of the BSDL-SI larger internal diameter with its main internal surface. This verification guarantees the correct position of the Round Blocks, and so of the Latch Bars, on the BSDL-SI Main Structure.

The verification described above shall be made during the test with the Dummy Cap. If during any test, described below, the upper and/or the lower rings don´t fit in the BSDL-SI, this one is reproved.

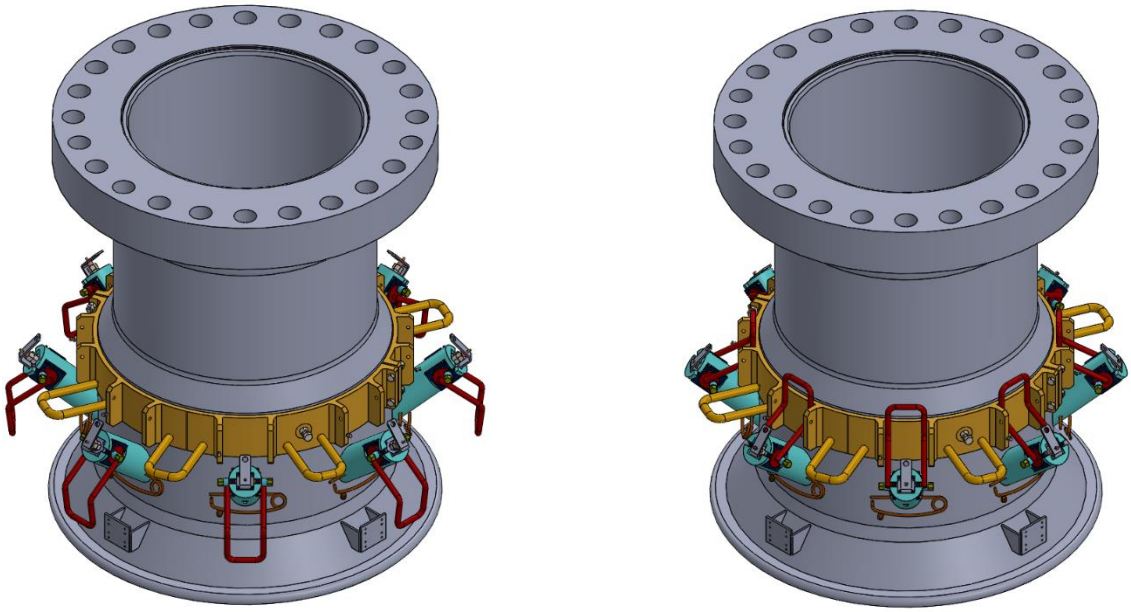
4. Latch bars mechanism alignment

4.1. Objective

This test aims to verify the latch bars mechanism alignment with the BSDL-SI inner surface.

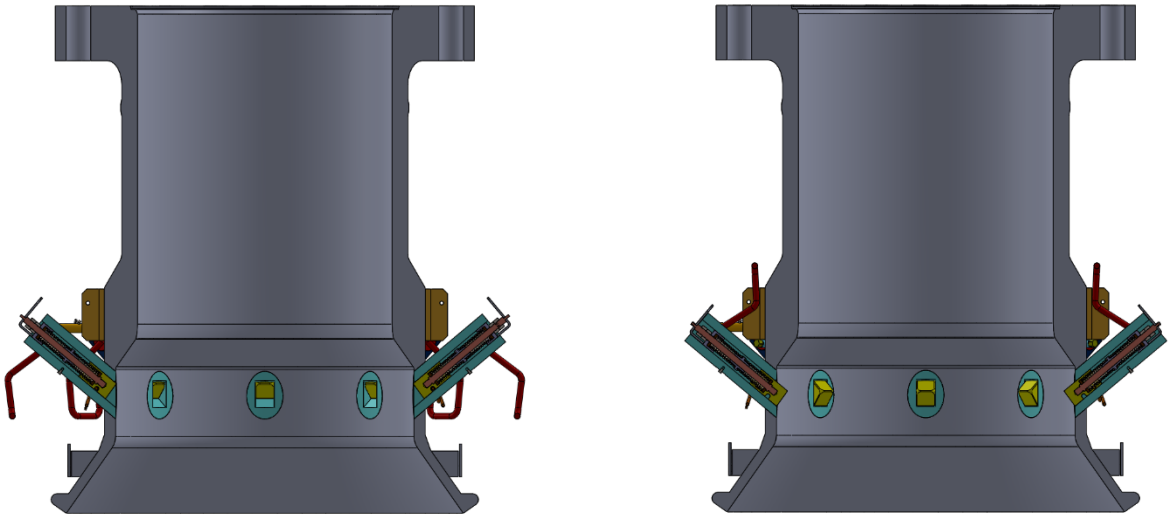
4.2. Procedure

a. Insert the clips in the round blocks, with the handles on the “lower” position and the latch bars on the “retracted” positions, Figure 2(a) and Figure 3(a).
b. Actuate 3 (three) times each handle, from “lower” to “upper” position, Figure 2. **(Acceptance Criteria Ra1, item 4.3.1).**
c. Return the handle to the “lower” position and extract the clip. Check if all latch bars are on the “retracted” positions. **(Acceptance Criteria Ra2, item 4.3.2).**
d. Actuate 3 (three) times each latch bar from “retracted” to “extended” position, Figure 3, using its respective handle. **(Acceptance Criteria Ra3, item 4.3.3).**



(a) *(b)*

Figure 2 – Handles: (a) Lower position and (b) Upper position.



(a) *(b)*

Figure 3 – Latch bars: (a) Retracted and (b) Extended.

4.3. Acceptance Criteria

4.3.1. Ra1

i. Handles performance: the only expected effort to do this movement is the one necessary to overcome the spring elastic strength. The reference strength necessary to actuate each handle is 3 Kgf (three kilograms force). If the operator is able to smoothly and softly move each handle, then this step is approved and one shall proceed to the next step. Register in the TRS. Otherwise, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

4.3.2. Ra2

i. All latch bars shall be “retracted”, Figure 3(a), and upper aligned with the BSDL-SI inner surface, Figure 4. If the gaps, presented between each latch bar and the BSDL-SI inner surface, are less than or equal to 3 mm (three millimeters), then this step is approved and one shall proceed to the next step. Register in the TRS. Otherwise, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

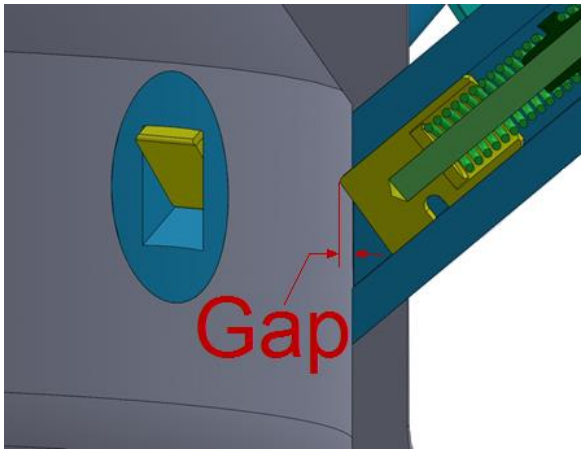


Figure 4 – Upper alignment, between latch bar and BSDL-SI inner surface.

4.3.3. Ra3

i. Visual inspection: Observe if the latch bars freely move between the “retracted” and “extended” positions. If they do, then this step is approved and one shall proceed to **Ra3**.ii criteria. Register in the TRS. Otherwise, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

ii. Handle and latch bar set performance: the only expected effort to do this movement is the one necessary to overcome the handle and latch bar set inertia. If the operator is able to smoothly and softly move each latch bar from the “retracted” position to the “extended” one, using only the respective handle, then this step is approved and one shall proceed to the next step. Register in the TRS. Otherwise, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

5. Test with the Dummy Cap

5.1. Objective

This test aims to verify the latch bars mechanism performance and alignment. This is done by observing the automatic and simultaneous expansion of the latch bars, after the passage of the Dummy Cap through the BSDL-SI.

5.2. Procedure

- Preparation
  e. Place the BSDL-SI with its cylindrical body plumb in relation to the lifting device;
  f. Place the Dummy Cap below the BSDL-SI and aligned axially with it and with the lifting device cable, with the four-legged sling passing inside the cylindrical body of the BSDL-SI.
  g. Attach the four-legged sling in the four upper eyebolts of the Dummy Cap symmetrically spaced and using the specified shackles.
  h. Check if all latch bars are “extended” and the handles are on the “upper” position, locked with the respective clips, Figure 3(b).
- Pull-in Test
  i. Pull the Dummy Cap into the BSDL-SI at a speed of 4 m/min (four meters per minute);
  j. Observe the insertion of the Dummy Cap on BSDL-SI and the latch bars simultaneous and automatic locking (**Acceptance Criteria Ra4, item 5.3.1**).
  k. Record the load cell measured in Report field.
  l. If the latch bars have been simultaneously and automatically expanded, spool out the lifting device cable so that the Dummy Cap is freely seated on the latch bars. Check how the Dummy Cap is seated on the latch bars, the expansion of the latch bars and measure the clearance between them and the Dummy Cap with a feeler gauge (**Acceptance criteria Ra5, item 5.3.2**).

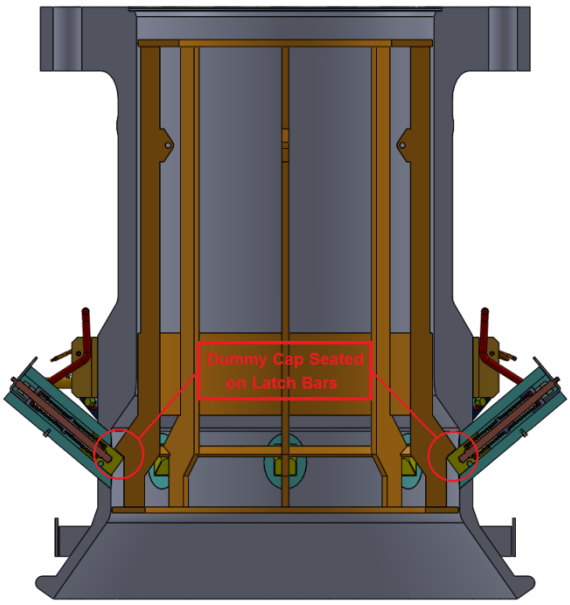


Figure 5 – Dummy cap seated on the latch bars.

- Pull-out Test
  m. Spool in the lifting device cable until the Dummy Cap is no longer seated on the latch bars.
  n. Individually actuate each handle to move the latch bars to the “retracted” position, Figure 3(a), allowing the removal of the Dummy Cap. (**Acceptance Criteria Ra6, item 5.3.3**).

o. Lower the Dummy Cap until it rests on the floor. (**Acceptance Criteria Ra7, item 5.3.4**).
p. Individually actuate each handle to move the latch bars to the “extended” position, Figure 3(b). (**Acceptance Criteria Ra8, item 5.3.5**).

- Test ended.

5.3. Acceptance Criteria

5.3.1. Ra4

i. The latch bars shall automatically and simultaneously expand after the passage of the Dummy Cap. The verification shall be made through the thud of the latch bars expanding. The thud of the latch bars locking shall be a single and “dry” sound, in unison. If this condition is met, then this step is approved and one shall proceed to the next step. Register in the TRS.

ii. Delays / advances sonorously perceived indicate that some latch bar is locking later / earlier than expected. If the sound is not single and “dry”, nor in unison, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

iii. If any latch bar does not expand, then the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

5.3.2. Ra5

i. The Dummy Cap is seated on all latch bars and all of them are evenly expanded or gaps presented between Dummy Cap and the latch bars are less than or equal to 2mm (two millimeters), Figure 5. This step is approved and one shall proceed to the next step. Register in the TRS.

ii. The Dummy Cap is seated in the following sequence: "One yes one no”. Check if the gap between the Dummy Cap and 2 (two) or more latch bars (not properly seated) is greater than 2mm (two millimeters). If so, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests. If not, this step is approved. Register in the TRS.

iii. The Dummy Cap is not seated on two adjacent latch bars. Check if the gap between the Dummy Cap and 1 (one) of the latch bars is greater than 2mm. If so, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests. If not, this step is approved. Register in the TRS.

iv. In the event of a combination of ii and iii deviations above mentioned, the test shall be decommissioned and the BSDL-SI shall be sent to repair, regardless the gap between the Dummy Cap and the latch bars. Register in the TRS. Then the tests must be restarted.

5.3.3. Ra6

i. Visual inspection: Observe if the latch bars freely move from the “extended” to the “retracted” positions. If they do, then this step is approved and one shall proceed

to **Ra6**.ii criteria. Register in the TRS. Otherwise, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

ii. Handle and latch bar set performance: the only expected effort to do this movement is the one necessary to overcome the handle and latch bar set inertia. If the operator is able to smoothly and softly move each latch bar from the “extended” position to the “retracted” one, using only the respective handle, then this step is approved and one shall proceed to the next step. Register in the TRS. Otherwise, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

5.3.4. Ra7

i. The Dummy Cap shall descend freely through the BSDL-SI and then rest on the floor. If the Dummy Cap descends freely, the step is approved. Register in the TRS. Otherwise, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

5.3.5. Ra8

i. All latch bars shall be “extended”, Figure 3(b), and lower aligned with the BSDL-SI inner surface, Figure 6. If the gaps, presented between each latch bar and the BSDL-SI inner surface, are less than or equal to 5mm (five millimeters), then this step is approved and one shall proceed to the next step. Register in the TRS. Otherwise, if the Latch Bar is on a cantilever position, Figure 7, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

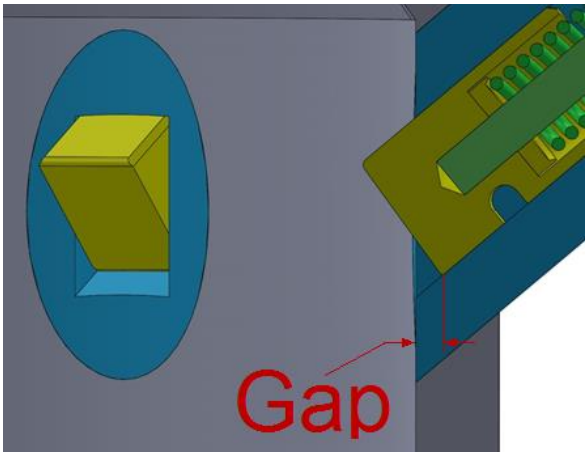


Figure 6 – Lower alignment, between latch bar and BSDL-SI inner surface.

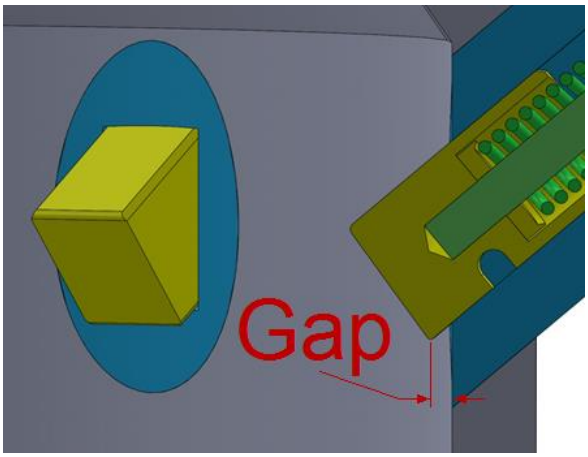


Figure 7 – Latch bar on cantilever position.

6. Electrical continuity test

6.1. Objective

The objective of electrical continuity test is to ensure that all BSDL-SI moving parts are electrically connected to the BSDL-SI main structure.

6.2. Procedure

q. Connect one micro-ohmmeter terminal to the flat surface on Round Block, Figure 8 - position 1.
r. Connect the other terminal to the Clip, Figure 8 - position 2. Proceed with measuring the electrical values **(Acceptance Criteria Ra9, item 6.3.1).**
s. Move the terminal positioned on the Clip and connect it to the Axis posterior region, near from the electric cable connection point, Figure 8 - position 3. Proceed with measuring the electrical values **(Acceptance Criteria Ra9, item 6.3.1).**
t. Repeat procedure “q” through “s” to every individual BSDL-SI locking mechanism.

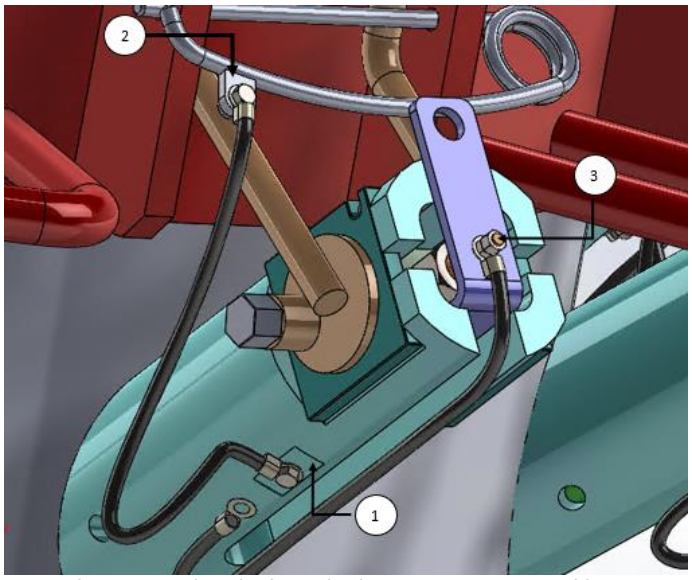


Figure 8 – Electrical continuity test measure positions.

6.3. Acceptance Criteria

6.3.1. Ra9

i. If all electrical values measured are in accordance with DNV-RP-B401, section 7.12.3, then this step is approved. Register in the TRS. Otherwise, the deviation shall be evaluated, the test shall be decommissioned and the BSDL-SI shall be sent to repair. Register in the TRS. Then restart the tests.

ANNEX B

1. TEST RECORD SHEET – TRS

1.1. General

The FAT procedure shall include a document to record the results of each step of the tests, named Test Record Sheet – TRS.

The TRS shall have a format according to the template in section 2 of this annex and present at least the contents listed in the section 1.2 below.

All sheets of all tests shall be filled out using pen.

IMPORTANT: As defined in section 16.4.6 of I-ET-3010.00-1300-279-PPC-301, the TRS of BSDLs-SI rejected and sent for scrapping shall be stored along with the data books set of approved BSDLs-SI.

1.2. Minimum Content

Seller can add any information considered necessary in the TRS, by inserting a new page at the end of the table.

The following fields shall be part of TRS.

1.2.1. Date
Date of the test.

1.2.2. Manufacturer
Manufacturer of the BSDL-SI.

1.2.3. Sheet
Indication of page number and total number of pages (ex.: 1/3, sheet 1 of 3, etc.).

1.2.4. Rep. Num.
Report number defined according to Seller's methodology.

1.2.5. ND
BSDL nominal diameter.

1.2.6. SN
BSDL serial number.

1.2.7. FPU
Production unit (FPSO- Floating Production Storage and Offloading) where the BSDL-SI will be installed.

1.2.8. Report
Field to be filled in with any information regarding the current test step.

1.2.9. AP/SR/RE
Indication of Approved, Send to Repair and Reproved (see1.3).

1.2.10. Ra1 to Ra3

Latch bars alignment and locking test.
1.2.11. Ra4 to Ra8
Tests with the Dummy Cap.

1.2.12. Ra9
Tests for electrical continuity.

1.2.13. Responsible
Name and signature of the responsible for releasing the BSDL-SI.

1.2.14. Result
Result of the tests, Approved or Rejected.

1.3. Fields AP, SR and RE

The AP, SR and RE fields shall be marked with an "X" or checked "√", in accordance with one of the three situations shown below.

1.3.1. AP – Approved
The BSDL-SI is released to the next test. This option will be marked alone if the test passes with no indication of repairs.

1.3.2. SR – Send to Repair
There was a deviation during the test and the BSDL-SI must be repaired and retested.

The deviation occurred shall be reported, as well as the description of what shall be done to repair the BSDL-SI. After repairing, the BSDL-SI shall be submitted to test again from the very beginning (Ra1 test).

In case of repairing the BSDL-SI, besides the SR field, the AP or RE field may be marked after the second test, depending on the result of this test. That is, if both AP and SR fields are marked, it means that the BSDL-SI was tested and failed; it was sent to repair, tested again and later approved. Similarly, if SR and RE are marked, it means that the BSDL-SI was tested and failed, it was sent to repair, tested again and failed again, indicating that it shall be discarded.

1.3.3. RE – Reproved
The BSDL-SI shall be discarded. This option will be marked alone if the rejection indicates discard without repairs.

IMPORTANT: As defined in section 16.4.5.1 of I-ET-3010.00-1300-279-PPC-350, the new BSDL-SI, manufactured to replace the rejected one, shall receive a new serial number.

2. Test Record Sheet – TRS Template

LOGO	**BSDL-SI TEST RECORD SHEET**

Sheet:	Manufaturer:	Rep. Num.:

BSDL-SI information:

ND	**SN**	FPSO

Subtitle:
AP - Approved.
SR – Send to Repair
RE - Reproved.

1. LATCH BARS ALIGNMENT.

crit.	step	report	AP	SR	RE
Ra1	**Handles operation & spring test.**				
Ra2	**Latch bars "retracted".**				
Ra3	**Handles & latch bars sets operation.**				

2. LATCH BARS LOCKING PERFORMANCE AND ALIGNEMENT.

crit.	step	report	AP	SR	RE
Ra4	**Latch bars locking operation**				
Ra5	**Dummy Cap seating.**				
Ra6	**Handles & latch bars sets operation.**				
Ra7	**Dummy Cap lowering.**				
Ra8	**Handles & latch bars sets operation.**				

3. ELECTRICAL CONTINUITY

crit.	step	report	AP	SR	RE
Ra9	**Electrical continuity**				

LOGO	**BSDL-SI TEST RECORD SHEET**

Sheet:	Manufaturer:	Rep. Num.:

BSDL-SI information:

ND	**SN**	FPSO

Subtitle:
AP - Approved.
SR – Send to Repair
RE - Reproved.

4. Observations

3. Result

ACCEPTED ☐ REJECTED ☐	
Date:	**Responsible (Signature and stamp):**