



ESPECIFICAÇÃO TÉCNICA

Nº

I-ET-2000.00-1180-25B-PPQ-001

PROGRAM: WELLS

PAGE: 1 OF 20

AREA: WELL STRUCTURE

POCOS

TITLE: Stage Collar and accessories, for surface casing applications (13 5/8" to 18")

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TODAS AS INFORMAÇÕES DESTE DOCUMENTO SÃO PROPRIEDADE DA PETROBRAS, SENDO PROIBIDA A UTILIZAÇÃO FORA DA SUA FINALIDADE.

FORMULÁRIO PADRONIZADO CONFORME NORMA PETROBRAS N-0381 REV. L.



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1 SUBJECT

This technical specification of requirements (TS-R) presents the minimal technical and functional prerequisites for stage collars with mechanical actuation, for applications in surface casings, from 13 5/8" to 18" of nominal diameter.

The document also presents the required qualification tests and acceptance criteria for Petrobras scenario.

Refinements required for the construction of each unit of stage collar (e.g.: steel grade, connection thread type) as well as the amount of units to be ordered will be supplied on a later document, called ET-RBS.

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2 SUPPLEMENTARY DOCUMENTS

ET-3000.00-1210-130-PPQ-1 – “Componentes Elastoméricos de Poço”

API RP 5C5, “Procedures for Testing Casing and Tubing Connections”, 2017.

API 19 AC – Specification for Completion Accessories;

API 96, Deepwater Well Design and Construction, 2013.

API SPEC Q1 – Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry.

API SPEC 10F - Cementing Float Equipment Testing, 2018

API SPEC 11D1 – Packers and Bridge Plugs

API SPEC 19OH – Openhole Isolation Equipment

ANSI/NACE MR0175/ISO 15156-1:2015 – Petroleum and Natural Gas Industries – Materials for use in H₂S-containing Environments in Oil and Gas Production

ISO-11960 – Steel pipes for use as casing or tubing for wells;

ISO 13679, Petroleum and natural gas industries — Procedures for testing casing and tubing connections, 2002.

ISO 14998, Petroleum and natural gas industries — Downhole equipment — Completion accessories, 2013.


ISO 14310, Petroleum and natural gas industries — Downhole equipment — Packers and bridge plugs, 2008.

ISO 23936-2 - Petroleum, petrochemical and natural gas industries — Non-metallic materials in contact with media related to oil and gas production — Part 2: Elastomers

API TR 6J1 - Elastomer Life Estimation Testing Procedures; First edition, August 2000

ASTM D741 16a - Standard Test Method for Rubber Property — Effect of Liquids

API 5CT:2011 – Specification for Casing and Tubing.

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ISO 10400:2007 – Petroleum and natural gas industries – Equations and calculations for the properties of casing, tubing, drill pipe and line pipe used as casing and tubing.

3 TERMS AND DEFINITIONS

- ET-R – “Especificação Técnica de Requisitos” – stands for Technical Specification for Requirements (TS-R)
- ET-RBS – “Especificação Técnica de Requisição de Bens e Serviços” – stands for Technical Specification of Supplies and Goods Requisitions. Documentation that details the bidding and is based on a TS-R.
- FMEA – Failure Modes and Effects Analysis;
- FMECA – Failure Modes, Effects and Criticality Analysis;
- TTF – Time To Failure
- OD – Outside Diameter
- ID – Inside Diameter
- Maximum absolute pressure – Maximum pressure equipment is expected to experience downhole
- Pinternal – Minimum resistance to internal pressure required for the collar.
- Pexternal – Minimum resistance to external pressure required for the collar.
- Working pressure – Pressure actuation on equipment, once operational.
- Service Shifting Tool – Tool used to operate stage collar, conveyed by drillpipe.



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4 FUNCTIONAL AND TECHNICAL REQUIREMENTS

4.1 Stage collar ensemble

- 4.1.1 The term stage collar ensemble will denote a stage collar and an inflatable packer, installed right below the collar.
- 4.1.2 If pup joints are necessary to compose the ensemble, or to perform a connection transition to the casing string, Petrobras can chose to be responsible for directly procuring these joints, if that will expedite delivery of the ensembles, or reduce their cost.
- 4.1.3 The ensemble must allow opening and closing of a string-to-annular communication, as commanded, enabling the cement to be pumped to the annular space between casing and open-hole, hereinafter called D-annulus. After the conclusion of the cement job, the stage collar must be permanently closed, composing an element of barrier, in the casing path. It must be compatible with one of the tubulars below:
- 4.1.3.1 Nominal OD = 13 5/8" ; Linear weight = 88,2 lb/ft
- 4.1.3.2 Nominal OD = 14" ; Linear weight = 115 lb/ft
- 4.1.3.3 Nominal OD = 18" ; Linear weight = 117 lb/ft or 162 lb/ft
- 4.1.4 The specification of the ensemble must follow Table 1 , Table 2 and Table 3. Such specifications can vary, depending on the contracting scenario. Different limits can be requested, on ET-RBS.



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Table 1 – Specifications for stage collar ensemble (13 5/8" to 14") with standard pressure limits

	Ensemble for 13 5/8", 88,2lb/ft, standard pressure limits	Ensemble for 14" 115 lb/ft, standard pressure limits
Maximum external diameter for stage collar ensemble	16.25"	16.25"
Minimum passage assurance (drift)	12 ¼"	12 ¼"
Typical corrosive environment	200 ppmV H2S pH = 4.3	200 ppmV H2S pH = 4.3
Minimum Yield Strenght	110 ksi	110 ksi
Minimum resistance to traction	2,246 klf	2,733 klf
Minimum resistance to compression	2,808 klf	2,733 klf
Minimum resistance to collapse (Pexternal)	4,490 psi	4,490 psi
Minimum resistance to burst (Pinternal)	8,000 psi	8,000 psi
Open hole diameter	Up to 17 ½"	Up to 17 ½"
Maximum wash-out tolerance (in diameter)	3"	3"

Table 2 – Specifications for stage collar ensemble (13 5/8" to 14") with extended pressure limits

	Ensemble for 13 5/8", 88,2lb/ft, extended pressure limits	Ensemble for 14" 115 lb/ft, extended pressure limits
Maximum external diameter for stage collar ensemble	16.25"	16.25"
Minimum passage assurance (drift)	12 ¼"	12 ¼"
Typical corrosive environment	200 ppmV H2S pH = 4.3	200 ppmV H2S pH = 4.3
Minimum Yield Strenght	110 ksi	110 ksi
Minimum resistance to traction	2,246 klf	2,733 klf

Minimum resistance to compression	2,808 klbf	2,733 klbf
Minimum resistance to collapse (Pexternal) *	6,370 psi	6,370 psi
Minimum resistance to burst (Pinternal) *	8,830 psi	9,780 psi
Open hole diameter	Up to 17 ½"	Up to 17 ½"
Maximum wash-out tolerance (in diameter)	3"	3"

* For Table 2, collapse and burst requirements can be lowered on ET-RBS, depending on contracting scenario.

Table 3 – Specifications for stage collar ensemble (18").

	Ensemble for 18" ; 117 lb/ft	Ensemble for 18" ; 162 lb/ft
Maximum external diameter for stage collar ensemble	20.5"	20.5"
Minimum passage assurance (drift)	16.562"	16.062"
Minimum Yield Strength	110 ksi	80 ksi
Minimum resistance to traction	2,342 klbf	2,260 klbf
Minimum resistance to compression	2,342 klbf	2,260 klbf
Minimum resistance to collapse (Pexternal)	2,110 psi	4,650 psi
Minimum resistance to burst (Pinternal)	6,680 psi	6,810 psi
Open hole diameter	Up to 24"	Up to 24"
Maximum wash-out tolerance (in diameter)	4"	4"

- 4.1.5 The traction and compression limits on tables 1, 2, and 3 refer to elastic regime only. No yield is admissible up to these values.
- 4.1.6 If H₂S service is required, ISO 15156 must be complied with.
- 4.1.7 The steel grades employed must be sufficient to withstand corrosive environments according to ET-RBS. Collars of 13 5/8" and 14" are expected face these environments.
- 4.1.8 Elastomeric materials must be qualified according to ET-3000.00-1210-130-PPQ-1. The fluids used and test details will be specified on ET-RBS.



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- 4.1.9 Connections of all tubulars of the ensemble will be detailed on ET-RBS.
- 4.1.10 The inflatable packer can be actuated hydraulically (by exertion of internal pressure) or mechanically (by traction / compression).
- 4.1.11 For hydraulically actuated packers, the nominal actuating pressure must be above 1,500 psi and below 2,000 psi. The maximum allowed tolerance for fluctuations in actuation pressure is of $\pm 10\%$.
- 4.1.12 For mechanically actuated packers, the axial force for deployment must be fall in the range between 50 kbf and 70 kbf. The maximum tolerance for fluctuations in actuation force is $\pm 10\%$.
- 4.1.13 The inflatable packer must be capable of being set inside open holes, accounting for overgauge. The maximum expected open hole diameters, considering wash-out, are listed on Table 4.

Table 4- Geometry for testing inflatable packer.

OD / nominal weight of stage collar ensemble	OD of external pipe (inches) , for testing inflatable element
13 5/8", 88,2 lb/ft	20.5
14", 115 lb/ft	20.5
18", 117 lb/ft	28
18", 162 lb/ft	28

- 4.1.14 The differential pressure to be withstood by the packer must consider the maximum diameter, that is, in a washed-out well. This differential pressure will be informed on ET-RBS. Here are some possible choices:
- 4.1.14.1 1,200 psi, for standard cement operations
- 4.1.14.2 2,000 psi, for extensive cement operations
- 4.1.15 The packer must be qualified according to API SPEC 19OH, validation grade V2OH, ISO 14310, validation grade V5, or API SPEC 11D1, validation grade V5. Stricter grades will also be accepted, for each of the mentioned standards.
- 4.1.15.1 Depending on the contracting scenario, ET-RBS can demand other validation grades, such as API SPEC 11D1 V4 (liquid test plus axial loads)
- 4.1.15.2 Work pressure for the packer will be specified on ET-RBS.



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4.1.15.3 Suggested temperature range, for testing the packer is $[4^{\circ}\text{C}; 7^{\circ}\text{C}]$. However, packer must be able to operate according to item 4.1.16

4.1.16 The stage collar and inflatable packer can be mounted on separated casing joints, as long as the resistance and connection criteria are met, for each tubular.

4.1.17 The stage collar ensemble must be projected to operate in any depth, for the following operational envelope:

4.1.17.1 Temperature: 4°C (Ti) - 140°C (Tf)

4.1.17.2 Maximum absolute pressure (Pa): 16,500 psi;

4.1.17.3 Possibility of application in vertical, directional or horizontal wells. The equipment must be capable of operating in dogleg severities of, at least, 5° / 100 ft.

4.1.18 The equipment design and the installation procedure (including support tools) must consider installation in subsea wells, for dynamic position rigs, in ultra-deepwater environments (up to 3,000 m of water depth).

4.1.19 The stage collar ensemble must have maximum length of 10 meters (34.81 ft). The ensemble must have free extremities, up to 1 meter (3.481 ft) from each termination. This intends to enable the coupling of handling racks and torque thongs.

4.1.20 The cement operation with the stage collar must be performed after the first stage, without the need to perform any addition trip, for either actuating the collar or setting the inflatable element.

4.1.21 Discrepancies or alternatives with regard to what was originally specified by Petrobras must be explicitly indicated, in a separate item of the vendor's Technical Purpose.

4.1.22 During its installation, along with the casing string, the collar must remain at closed position. It must also remain closed during the first stage cement job.

4.1.23 Mechanically actuated port collars must be able to open while experiencing a pressure differential of 500 psi, from the inside to the outside.

4.1.24 After the second stage cement job, the collar must be actuated to the closed position. The collar internal profile must prevent it from opening, unless engaged by specific service tool.

4.1.25 The collar must possess a permanent-close mechanism, to be actuated after the second cement job. It is preferable for such mechanism to be activated on the same trip as the one performed for the second stage cement job.

4.1.26 After permanently closed, the collar must, remain closed. The collar must not open involuntarily or leak during subsequent operations, such as:

4.1.26.1 BHA deployment

4.1.26.2 Drilling of the next phase

4.1.26.3 Casing tests, or internal pressurizing.

4.1.27 The stage collar design must enable mechanical separation between the cement slurry and spacer fluid. A dart or plug must be pumped between slurry and spacer fluid, in order to avoid slurry contamination.

4.1.28 The holes drilled on collar body, which allow cement to be pumped to the annulus, must have, at least, 1 1/4" in diameter each. It is required, at least, 4 orifices (which add up a drilled surface of 4,9 in²). In order to allow a more homogeneous flow, on the azimuthal direction, the orifices are required to have an azimuthal offset, between one another.

4.1.29 Supplier must provide an operational envelope for the stage collar ensemble, in the shape of a 2D-plot, similar to the operational efficiency envelopes of API 5C5 tubulars (see Figure 1).

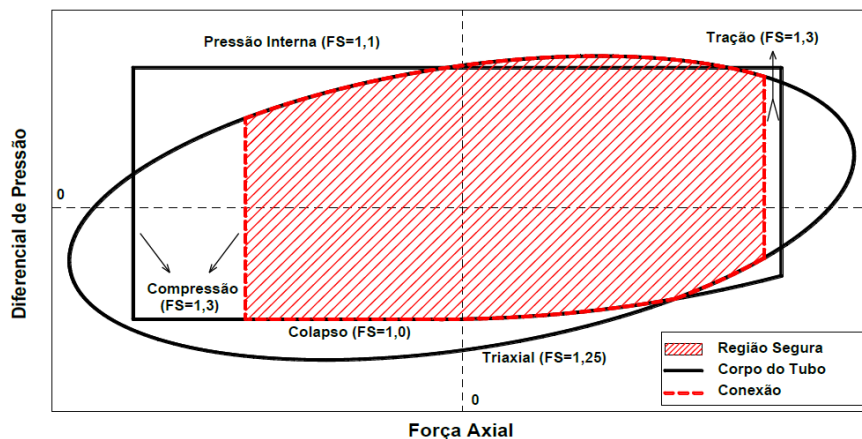



Figure 1 - Example of Von Mises envelope and API thresholds.

4.1.30 At ambiente temperature (20°C), the stage collar must be able to withstand pressure and axial loads, according Tables 1, 2 and 3.

4.2 Shifter tool

4.2.1 The Shifter Tool consists in a tubing-conveyed accessory which allows will actuate the collar, either by rotation or translation. It refers only

4.2.2 The maximum OD of the shifter tool must be compatible with 16 3/4" wellhead systems, with surface casing drifts (Table 1 ; Table 2 ; Table 3) and, evidently, with the drift of stage

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collar ensemble. The drift of such systems will be informed on ET-RBS. Here are some possible values:

4.2.2.1 16"

4.2.2.2 18 1/8"

4.2.3 For applications with 18" 117 lb/ft casings, shifter tool string cannot exceed 16.562". In this case, minimum drift expected for wellhead system is 17.5"

4.2.4 The profile or dogs mounted over the shifter tool must have a higher hardness than surface casing and stage collar interior, so that it won't wear out during stage collar actuation.

4.2.5 Connections must be compatible with workstring drillpipes. Such connections will be specified on ET-RBS. Here are some possible choices.

4.2.5.1 4 1/2" IF 13,5 lb/ft box x pin;

4.2.5.2 6 5/8" 28 lb/ft box x pin;

4.2.6 Internal pressure (burst) resistance: 7,500 psi;

4.2.7 External pressure (collapse): 7,500 psi;

4.2.8 Tension / compression limits for shifter tool will be specified on ET-RBS, so that they can meet the limits of the work string. Values typically encountered in Petrobras rigs are listed below.


4.2.8.1 Minimum tension limit = 400 lkb;f;

4.2.8.2 Minimum compression limit = 200 lkb;f;

4.2.9 For mechanically actuated stage collars, the shifter tool must possess flow rerouting mechanisms, in order to:

4.2.9.1 Enable circulation and cementing by drillstring extremity, for 1st stage cement job, while preventing unwanted leakage to annular space between shifter tool and casing (hereinafter called C-annulus).

4.2.9.2 Enable circulation and cementing through stage collar, while ensuring isolation of drillstring extremity, therefore, preserving 1st stage cement job. In addition, during the 2nd stage cement (through collar), all flow must be directed to the D-annulus, ensuring that there's no upward or downward flow in C-annulus.

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4.2.10 The shifter tool must allow for sealing tests to be performed, on the chamber between tool communication port and casing bore. This test must be performed prior to cement job, to ensure realization of items 4.2.8.1 and 4.2.8.2.

4.2.11 The shifter tool must possess mechanisms to avoid well surge or swab, during its trip-in or trip-out procedures.

4.3 Translational actuation

4.3.1 Collars with translational actuation are those which actuation is given by translation of shifter tool, relative to stage collar. These collars must open when moved downwards (open down) and close, if switched upward (close up);

4.3.2 The minimum force required, for both opening and closing of stage collars, must be of 50 klf. This value aims to provide operator with enough measuring sensibility, on Martin - Decker. The necessary force, for opening and closing stage collars, must be smaller than 70 klf.

4.3.3 The stage collar must possess a permanently closed position (lock-closed), that once triggered will prevent collar from re-opening.

4.4 Rotational actuation

4.4.1 The minimum torque required, for both opening and closing of stage collars, must be of $2 \text{ klf} \cdot \text{ft}$. This value aims intends to provide operator with enough measuring sensibility, on top-drive.


4.4.2 The maximum torque allowed, for both opening and closing of stage collars, is $15 \text{ klf} \cdot \text{ft}$. This value aims to avoiding over-torquing connection threads in workstring;

4.5 Combined actuation

4.5.1 This item refers to collars which rely on both rotation and translation of the shifter tool, to open or close. In this case, premises on items 4.3 and 4.4 must be respected.

4.6 Stage collar accessories

4.6.1 If the stage collar operation requires pumping plugs, darts or spheres, such elements must respect items 4.7.2 to 4.7.4.

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4.6.2 All accessories must be compatible with drillpipes, to be defined on ET-RBS (e.g.: 5" ; 6 5/8"); For that matter, accessories must observe diameter restrictions of drillstring tubes; Those restrictions typically vary from 2.750 pol to 5.901 pol).

4.6.3 Darts for the same function must be identically built, with interchangeable rubber parts.


4.6.4 Darts for different functions must have different colors and clear labels, on its fins.

4.7 Installation service

4.7.1 Supplier must participate on planning of operations, from the moment that the accessories and tools arrive to rig-site.

4.7.2 Supplier must follow collar operations on the rig. Personnel involved must be qualified for the necessary tasks. Technicians in charge must follow all steps of operation, including installation, collar opening, cementing and collar closing.


4.7.3 If a failure event is observed, on any component of the collar ensemble, Petrobras must be promptly notified.

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5 QUALIFICATION TESTS


5.1 General requirements

- 5.1.1 All equipment must be qualified, through factory tests. These tests must ensure compliance with the present technical specification. Tests must also enable suitability to transport, storage, installation and operation requirements of all products.
- 5.1.2 Qualification must contain, at least, tests described on this section, for reference, and equipment rating. Any additional test employed must be reported.
- 5.1.3 Description of all tests and corresponding results must be reported, as well as inspection and traceability data for the utilized materials.
- 5.1.4 Supplier must execute the tests hereby described, with the supervision of an independent certifying agency; Tests must be done at supplier's cost. Petrobras must be allowed to witness and follow each and any of the tests.
- 5.1.5 Should a qualified equipment undergoe any change on its technical specifications, this equipment must be, once again, analyzed and accepted by Petrobras.
- 5.1.6 If the modifications mentioned on 5.1.1.5 are deemed as significant, by Petrobras, a new qualification process must be executed and presented, so that the modified product can obtain qualification.
- 5.1.7 Items 5.2 through 5.4 describe acceptance tests which are mandatory for contracting.
- 5.1.8 Item 5.5 (reliability in closed position) describes a test with informational purposes and only applies to mechanically actuated collars, with translational actuation. While this test must be executed for translational collars, it doesn't contain any acceptance criterium.
- 5.1.9 Supplier must present, prior to the tests, fabrication tollerances applicable to the stage collar dimensions. A specimen must be chosen in order to represent worst case geometry that can be produced in the assembly line.

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5.2 Functional test

- 5.2.1 Command opening of the port collar.
- 5.2.2 For mechanically actuated collars, test must be executed with shifter tool engaged inside port. Collars will be actuated by shifter, to reproduce what would happen on downhole.
- 5.2.3 Acceptance criterium: Verification of complete opening of the ports.
- 5.2.4 Command closing of the port collar, to permanent lock position.
- 5.2.5 Acceptance criteria
 - 5.2.5.1 For mechanically actuated collars, opening or closing forces must of, at least, 45 klbf.
 - 5.2.5.2 For hydraulically actuated collars, opening or closing pressures must stay near the design values and fall within a $\pm 10\%$ range.
 - 5.2.5.3 Acceptance criterium: verify complete closure of collar orifices. No visible damage is admitted until this step. This applies to both metallic non-metalic components.

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5.3 Sealing test

- 5.3.1 Must be performed with same specimen used in functional test (item 5.2), after this test has been concluded.
- 5.3.2 Keep system temperature at $50^{\circ} C \pm 3^{\circ} C$ ($120^{\circ} F \pm 5^{\circ} F$).
- 5.3.3 Apply pressure differential equivalent to P_{internal} , from inside to outside of stage collar, during, at least, 15 min. Please refer to Tables 1, 2 and 3 for P_{internal} .
- 5.3.4 Apply pressure differential equivalent to P_{external} , from outside to inside of the collar, during, at least, 15 min.
- 5.3.5 Acceptance criterium: For each of the steps 5.4.3 and 5.4.4, the maximum pressure fall rate allowed is of 1% of the pressure on the upstream chamber (the one being pressurized), for a 15 min time *interval*. This criterium is similar to the one described on ISO 14998, Annex A, item A.3. A hold period can be awaited, for pressure stabilization, before the 15 minutes are counted.
- 5.3.6 Report upstream and downstream chamber volumes, on test report, for each of the steps 5.4.3 and 5.4.4.
- 5.3.7 Cool down system to $10^{\circ} C \pm 3^{\circ} C$.
- 5.3.8 Repeat steps 5.4.3 and 5.4.4, for $10^{\circ} C \pm 3^{\circ} C$.
- 5.3.9 Acceptance criterium: the maximum pressure fall rate allowed is of 1% of the pressure on the upstream chamber (the one being pressurized), for a 15 min time interval. This criterium is similar to the one described on ISO 14998, Annex A, item A.3. One must not supply the upstream chamber with pressure, during the test. A hold period can be awaited, for pressure stabilization, before the 15 minutes are counted.
- 5.3.10 Report upstream and downstream chamber volumes, on test report, for each of the steps 5.4.3 and 5.4.4 (this time, at $10^{\circ} C \pm 3^{\circ} C$).

5.4 Reliability test in closed position

- 5.4.1 This test aims to detect whether collars are susceptible to undesirably open, in response to axial loads, after they have been set closed. Axial loads are expected during subsequent drilling or completion activities. This test must be performed with same specimen used on sealing test (item 5.3), after that test has been concluded.
- 5.4.2 This test only applies to mechanically actuated collars, with translational actuation. A shifter tool or equivalent device must be latched to the moving part of the collar and apply an axial load, with variable intensity. It may be necessary to modify the shifter tool, so that higher loads can be achieved, for this test.

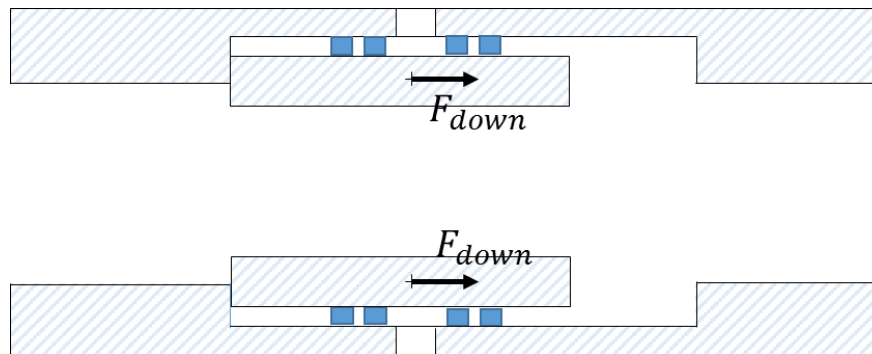


Figure 2 – Longitudinal section of collar during reliability test, for downward axial load

- 5.4.3 Apply an axial load of $F_{down,1} = 10 \text{ klb}$, towards the downhole side of the collar.
- 5.4.4 If collar remains closed, reverse axial force applied to $F_{up,1} = 10 \text{ klb}$, towards the surface side of the collar.

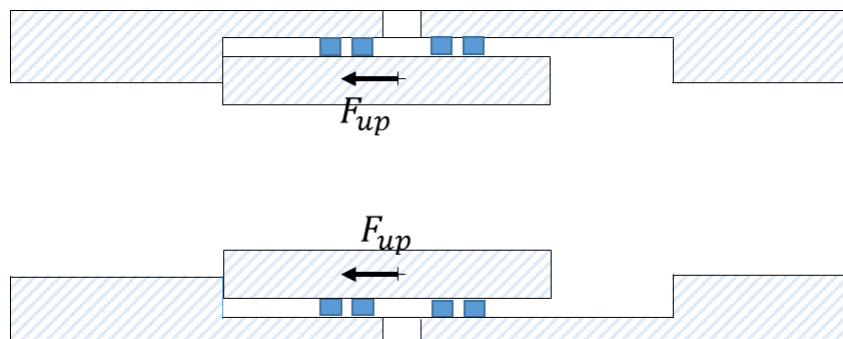


Figure 3 – Longitudinal section of collar during reliability test, for upward axial load

- 5.4.5 If collar remains closed, increase the axial loads by 10 klb



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POCOS/CTPS/QC

$$5.4.5.1 \quad F_{down,2} = F_{down,1} + 10klbf$$

$$5.4.5.2 \quad F_{up,2} = F_{up,1} + 10 klbf$$

5.4.6 Apply an axial load of $F_{down,i}$, towards the downhole side of the collar.

5.4.7 If collar remains closed, apply an axial load of $F_{up,i}$, towards the surface side of the collar.

5.4.8 If collar remains closed, keep increasing the axial loads by $10 klbf$.

$$5.4.8.1 \quad F_{down, i+1} = F_{down, i} + 10klbf$$

$$5.4.8.2 \quad F_{up, i+1} = F_{up, i} + 10 klbf$$

5.4.9 Repeat steps 5.4.6 to 5.4.8, until one of the collar opens or if until any of the axial loads has reached $150 klbf$.

5.4.10 If collar remains closed at the end of the test, perform a seal test, at ambient temperature, $T_{f,test} = 20\text{ }^{\circ}\text{C}$.

5.4.10.1 Apply 500 psi of pressure differential, from the inside to the outside of the collar.

5.4.10.2 Report leaked volume, for 5 minutes.


5.4.10.3 Apply 500 psi of pressure differential, from the outside to the inside of the collar.

5.4.10.4 Report leaked volume, for 5 minutes.

6 PRODUCTION INSPECTION

Requirements for inspection and production for stage collars purchases can be found on the technical specification ET-3000.00-1000-972-P8L-001. This spec can be obtained on Petrobras Supplier Channel

(<http://sites.petrobras.com.br/CanalFornecedor/portugues/requisitocontratacao/requisitocotratacao.asp>)

	ESPECIFICAÇÃO TÉCNICA	Nº	I-ET-2000.00-1180-25B-PPQ-001	REV.	0
	WELLS			FOLHA	20 de 20
	TÍTULO:	Stage Collar and accessories, for surface casing applications (13 5/8" to 18")		PÚBLICO	
				POCOS/CTPS/QC	

7 DOCUMENTATION

All documents must be available in electronic media using PDF format. The documents described in this section are scope of supply and must be available to Petrobras approval.

- 7.1 Detailed operational procedures for installing the collars.
- 7.2 Complete mechanical drawing of the entire equipment, containing dimensions and enough technical details, so that the design can be appraised in reference to this TS-R
- 7.3 Mechanical drawings for each component, including dimensions and enough technical details, to support installation and fishing operations.
- 7.4 Technical manual for each component, containing, at least: part number, description, materials utilized during production, operational envelope and report for qualification tests.
- 7.5 Calculation memorial, for sizing of each component.
- 7.6 If supplier possesses ISO 14998 or ISO 14310 qualification for the collar, related documentation must be presented
- 7.7 Specification of elastomeric materials and choice criterium.
- 7.8 Description of equipment, tools and accessories.
- 7.9 FMECA (Failure Mode, Effects and Criticality Analysis), to be composed in cooperation with Petrobras technicians.

OBS.: Studies and calculation memorials must be included in reports, which will constitute part of the supplying scope.

- 7.10 List of sub-components and equipments, with name of corresponding vendors (sub-suppliers), model, application and indication whether the referred part is a prototype or not.
- 7.11 All drawings must be on A3 format.
- 7.12 Section containing list of expected dimensional deviations, inherent to factory uncertainties (if applicable).