PETROBRAS	DESCRIPTION REPORT	Nº: I-MD-0000.00-1519-940-P9U-002	
	CLIENT: E&P		SHEET: 1 of 13
	JOB: PROD1000		CC
	AREA QUALIFICATION		DR20378
DDP	TÍTLE: PROD1000 PRE-QUALIFICATION PLAN – FLEXIBLE JOINTS		EDD/EDR

INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	**ORIGINAL**
A	INCLUDED: abbreviation for CoR, in Table 2; Loading data (tensions and angles) from riser global analyses, in Table 3; Time series files of top tension and angle variations, sec. 3.3.1. ALTERED: renumbered items of section 4 from item iv. EXCLUDED: item iv of section 4. GENERAL REVISION of the text or clarity.
B	ALTERED: updated tension and angle values for the Riser Families I and II, and for the load condition ULS3, in Table 3; Annex file format, sec. 3.3.1.
C	INCLUDED: References [6], [7] and [8] for basket profiles drawings, sec. 1.3; Demand for FXJ compatibility assessment with basket, item 2–vi; New condition requiring new qualification for Key Variable VII, sec. 3.2; Request for FXJ description as part of the pre-qualification, item 4–i; Description of the FXJ as one of the Deliverables, sec. 5 item i; Request for General Arrangement drawings of the offered FXJ in Deliverables, sec. 5 item vi. ALTERED: Codes and revisions (year of amendment) of refs. [1] and [2] and revisions of refs. [3] and [4], sec. 1.3; Premises/ restrictions items 2–iv and 2–v to allow the offer of new FXJ designs with different primary fluid barrier type; Revised specific condition for Key Variable V; Revised test specification reference for Key Variables VIII and IX; Renumbered items of section 2 from item 2–vi; Renumbered items of section 4 from item 4–ii; Renumbered items of section 5 from item 5–ii. EXCLUDED: reference [5]. GENERAL REVISION of the text or clarity.
D	INCLUDED: refined operating envelopes of P & T, for I–II–A, III–A and IV–A related with PO\SERV risers, in Table 3; Excel spreadsheet file with these native envelope points, sec. 3.1; qualification test as per sec. 6.4 of ref. [3], in Table 4.
E	ALTERED: minimum temperature requirement, in Table 3.

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	31/05/2021	31/08/2021	26/11/2021	14/07/2022	14/04/2023	23/02/2024			
PROJECT	PROD1000	PROD1000	PROD1000	PROD1000	PROD1000	PROD1000			
EXECUTION	TS8H	TS8H	TS8H	TS8H	TS8H	TS8H			
CHECK	CWDO; RVYZ	CWDO; RVYZ	CWDO	BF6J	BF6J	DXY4			
APPROVAL	CLZ2	CLZ2	CLZ2	CLZ2	CLZ2	BF6J			

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1 INTRODUCTION

1.1 PROGRAM DESCRIPTION

PROD1000 is a Petrobras strategic initiative aiming to reduce the overall schedule for the development and implementation of a production system for a new field. The goal of this initiative is starting oil production in a new field in a period of 1000 days from the date of oil confirmation in a pioneer well.

Several actions are being developed to accomplish this goal. Initiative 6.3 (*Padronização e Pré-Qualificação de Dutos Rígidos*) is one of them and is responsible for the standardization of subsea pipeline systems and pre-qualification of critical components, such as riser top connectors – i.e. Flexible Joints (FXJ), Titanium Stress Joints (TSJ) or Titanium Pull–in Tube (TiPT), pipes, coatings, buoyancy modules, valves and PLET connectors.

The rigid pipelines design area as part of the Subsea Engineering activity is envisaging the development of standardized design concepts and aiming to supply only previously pre-qualified components.

1.2 TERMINOLOGIES, DEFINITIONS AND ABBREVIATIONS

The terminology, definitions and abbreviations within this data sheet are in accordance with references [1], [2] and [4]. Additional terminologies, definitions and abbreviations are used as presented in Table 2.

The Riser Families for the PROD1000 are summarized on Table 1:

Table 1 – Design Families of PROD1000.

FAMÍLY	PROJECTS	WD (m)
(I) High WD and High CO_2	Fields with temperatures from 70°C to 110°C*	2350 – 3100
(II) High WD and Low CO_2	Fields with temperatures from 70°C to 110°C*	2350 – 3100
(III) Pre-Salt of Santos Basin	Fields with temperatures from 70°C to 110°C*	Up to 2350
(IV) High Pressure	Fields with temperatures from 70°C to 110°C*	1900 – 2100

* Maximum temperature through pipeline.

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Table 2 – Terminologies, Definitions and Abbreviations

PETROBRAS	PETRÓLEO BRASILEIRO S/A. – PETROBRAS Where referred to in this Specification, it means both the Company itself and its employees authorized to communicate with INTERESTED PARTY.
INTERESTED PARTY	A company participating in the Flexible Joint Qualification effort in preparation for the various EPCIs of PROD1000 Projects with FXJ technology.

ALS	Accidental Limit State
Cf	Case Factor, and per ref. [5]
CoR	Center of Rotation on the Flexible Joint
CRA	Corrosion Resistant Alloy
CS	Carbon Steel
ECA	Engineering Critical Assessment
FPSO	Floating, Production, Storage and Offload
FXJ	Flexible Joint
GI	Gas injection riser
ID	Inner diameter
IWAG	Water Alternating Gas Injection riser
NDT	Non-Destructive Test
OD	Outer Diameter
PLET	Pipeline End Termination
PO	Oil production riser
PoD	Probability of Detection
PQT	Pre-Qualification Trial
SERV	Service riser
TiPT	Titanium Pull–in Tube
TSJ	Titanium Stress Joint
UF	Utilization Factor
ULS	Ultimate Limit State
UNS	Unified Numbering System
WD	Water Depth
WI	Water Injection line
WoL	Weld Overlay
WT	Wall thickness

Shall	Indicates a mandatory requirement.
Should	Indicates a preferred course of action.
May	Is used where alternatives are equally acceptable.

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1.3 REFERENCES

All equipment supplied under the scope of this specification shall be in conformance to the latest editions of the design codes, standards, and PETROBRAS' documents listed hereafter in this section.

Ref. n°	Document number	Title	Rev.
[1]	DNV-ST-F101	Submarine Pipeline Systems	2021
[2]	DNV-ST-F201	Dynamic Risers	2021
[3]	I-ET-0000.00-0000-290-P9U-001	Flexible Joint Qualification	C
[4]	I-ET-0000.00-0000-290-P9U-003	Flexible Joint Specification	I
[5]	API RP 2RD	Design of Risers for Floating Production Systems (FPSs) and Tension-Leg Platforms (TLPs)	2009
[6]	I-DE-0000.00-0000-140-P9U-001	Conical Receptacle "Type A" – Basket Profile Dimensions	C
[7]	I-DE-0000.00-0000-140-P9U-002	Conical Receptacle "Type B" – Basket Profile Dimensions	C
[8]	I-DE-0000.00-0000-140-P9U-003	Conical Receptacle "Type C" – Basket Profile Dimensions	C

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2 SCOPE OF DOCUMENT AND PREMISES

2.1 SCOPE OF DOCUMENT

This Description Report defines the pre-qualification plan for the critical component FLEXIBLE JOINT, which needs to be fulfilled for the aforementioned component supply be eligible for PROD1000 type projects.

2.2 PREMISES AND RESTRICTIONS

i. The pipelines proposed for PROD1000 Projects were grouped into twelve standard types (06-off ID=6in and 06-off ID=8in), and then six representative scenarios of 8in ID were chosen for qualification, related with PO/SERV and GI conditions, as per Table 3. FXJ qualified for ID=8in will be considered also qualified for ID=6in.

ii. Each scenario of Table 3 represents a set of operating conditions that could be applicable for one or more risers. For instance, a convertible PO riser that may also operate as GI or IWAG in some moment during field exploitation.

iii. INTERESTED PARTY may qualify for the envelope of most stringent conditions among all the scenarios, following the key variables of sec. 3.2, which will be considered as qualifier for all the scenarios, or may choose a specific set of conditions/ scenarios to qualify only for this set.

NOTE 1: It is important to highlight that the eventual supplies of FXJ for PROD1000 Projects will be restricted to the qualified scenario(s), and that some risers can perform more than one conditions\ scenarios, as stated in sec. 2.2–ii.

iv. The tests to be considered for FXJ pre-qualification may be planned and carried out specifically for this program, or may have been carried out within the scope of previous project or qualification effort, provided in both cases that the conditions of the scenarios described in the Table 3 and the requirements of item 3.2 are respected. In this context, consider that:

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a. Track record of previous qualification tests may be accepted, provided that it complies with the design described in sec. 1.3 of ref. [4], in addition to ref. [3] and the provisions of this description report.

b. Track record of FXJ supply may be accepted, provided that it complies with the FXJ design described in sec. 1.3 of ref. [4], and can demonstrate effective operation for at least 03 years under conditions that encompass one or more of those of listed in sec. 3 for PROD1000 scenarios.

c. New designs, different from the description given in in sec. 1.3 of ref. [4], that were not previously supplied to or assessed by PETROBRAS, shall be qualified within PROD1000 initiative, as per applicable scope of ref. [3].

v. Bellow barrier shall be preferably specified for PROD1000. The nonuse of bellow barrier, the use of modified bellow design, or the employment of different barrier type (e.g., double elastomeric barrier), if considered, shall be qualified within this initiative, per Key Variables from I to VII.

vi. Dimensional Compatibility Assessment shall be carried out for the FXJ and PETROBRAS' Standard Receptacles of ref. [6], ref. [7] and ref. [8]. This Assessment is just informational, and will not result in exclusion of the pre-qualification, but serve as indication to PETROBRAS to confirm or to start a study to adapt the interface with FPSO.

vii. PETROBRAS will evaluate the documentation submitted by the INTERESTED PARTY and, at its discretion, determine whether the product in question can be considered as "pre-qualified". Section 5 presents the minimum list of documents to be delivered to PETROBRAS.

viii. Every test performed and the related documentation to be submitted for evaluation by PETROBRAS shall present evidence of witnessing by a third party or by a PETROBRAS inspector (own or outsourced).

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3 PRE-QUALIFICATION SCENARIOS AND KEY VARIABLES

3.1 SCENARIOS

A pre-qualification shall be performed for each of the scenarios presented in Table 3.

Scenarios I–II–A, III–A and IV–A related with PO\SERV risers and I–II–B, III–B and IV–B related with GI\IWAG risers (gas injection phase).

Table 3 – Scenarios and Service Conditions at Top Riser.

(continues)▶

Riser Family	Scenarios	RISER PIPE DATA				MINIMUM OPERATING	
		ID . [mm]	OD . [mm]	WT(1) . [mm]	Steel Grade per ref. [1]	Min. Op. Pressure [MPa]	Min. Op. Temp. [°C]
I and II	I-II-A	203.2	257.2	27	DNV485	0	-30(6)
	I-II-B						
III	III-A	203.2	261.2	29	DNV450	0	-30(6)
	III-B						
IV	IV-A	203.2	277.2	37	DNV485	0	-30(6)
	IV-B						

▶ *(continues)*▶

Riser Family	Scenarios	MEAN OPERATING (Long-Term)			MAXIMUM OPERATING (Cf=1.0) [ULS3]			
		MEAN. Op. Pressure [MPa]	MEAN. Op. Temp. [°C]	MEAN. Op. Tension(2) [kN]	Max. Op. Pressure [MPa]	Max. Op. Temp. [°C]	Max. Op. Tension(2) [kN]	Max. Op. Angle(2) [deg]
I and II	I-II-A	(5)	(5)	3507	41.3	100	4971	7.07
	I-II-B	55.0	55	3373	60.5	70	4702	8.44
III	III-A	(5)	(5)	2654	41.3	100	4057	7.76
	III-B	55.0	55	2620	60.5	70	3824	9.84
IV	IV-A	(5)	(5)	3323	75	100	4819	6.57
	IV-B	76.0	55	3270	83.6	70	4554	7.66

▶

Riser Family	Scenarios	EXTREME 1 (Cf=1.2) [ULS2]		SURVIVAL 2(3) (Cf=1.5) [ALS3]		EXTREME 2(4) (Cf=1.2) [ULS4]		TEMPORARY 1 (Cf=1.35) [ULS1]		
		Tension(3) [kN]	Angle(3) [deg]	Accidental Tension(2) [kN]	Accidental Angle(2) [deg]	Incidental Pressure [MPa]	Incidental Temp. [°C]	Tension [kN]	Angle [deg]	Test Pressure [Mpa]
I and II	I-II-A	5408	7.79	4449	17.37	45.4	100	4534	4.19	47.7
	I-II-B	5044	9.06	4281	19.19	66.5	70	4360	5.94	69.8
III	III-A	4411	8.63	3631	18.38	45.4	100	3702	4.30	47.7
	III-B	4115	10.75	3472	20.32	66.5	70	3533	6.22	69.8
IV	IV-A	5207	7.31	4376	15.44	82.5	100	4431	3.63	86.6
	IV-B	4880	8.37	4178	16.10	92.0	70	4227	4.80	96.6

(1) Total riser pipe thickness including 3.0mm of CRA layer, not considered for riser strength.
(2) Static plus dynamic tension, rotating angle.
(3) Associated with maximum operating pressure and maximum operating temperature.
(4) Associated with riser Max. Op. Tension and Max. Op. Angle.
(5) Refined Operating Envelopes of P & T, for I–II–A, III–A and IV–A related with PO\SERV risers, are given in Figure 1.
(6) Qualification shall consider -25°C continuously (>24 hours) with a step of -30°C for 1 hour after temperature equalization. In the worst case, at least -25°C continuously shall be qualified.

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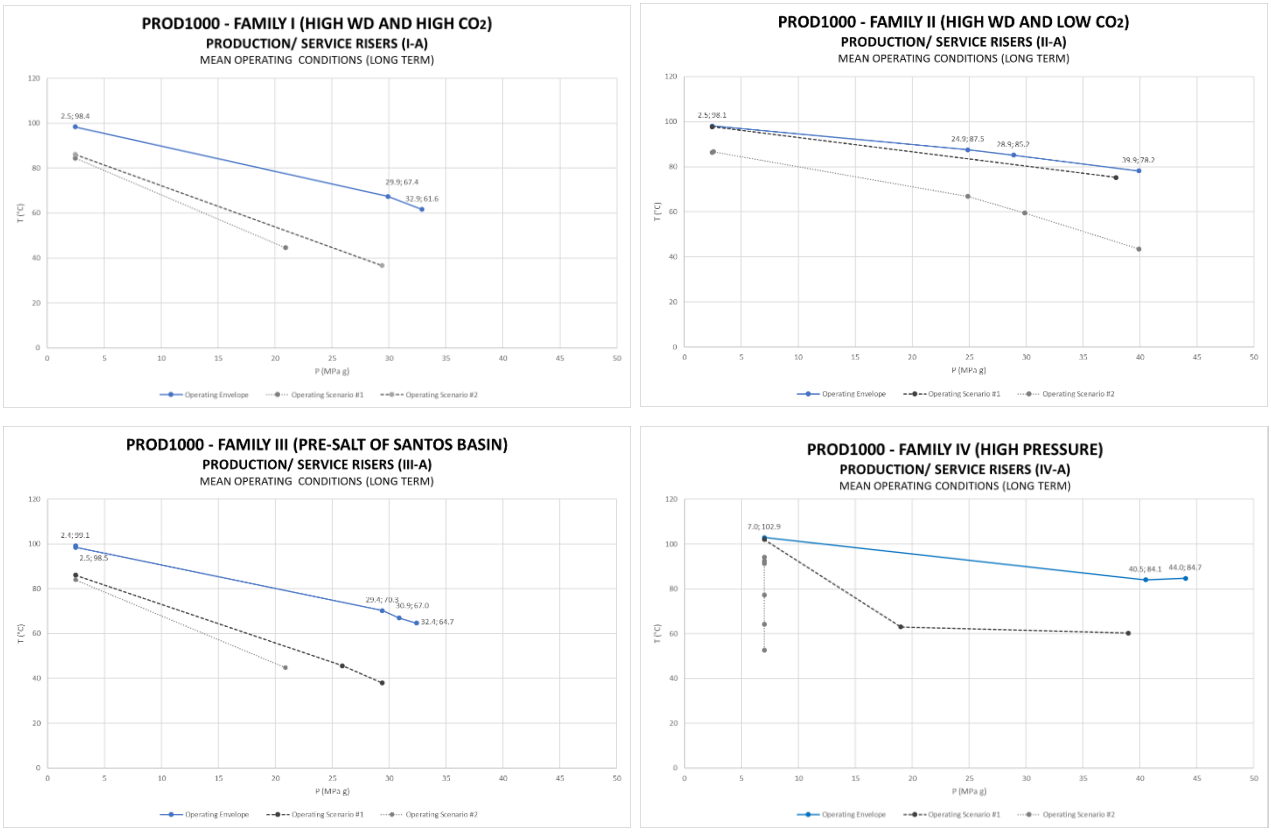

Figure 1 – Mean Operating Conditions (Long Term) for Production/ Service Risers → (📌).

Operating (long term) envelope conditions of P & T include the expected scenarios for all benchmark fields of each Family. INTERESTED PARTY shall consider the maximum overall P associated with the maximum overall T, or alternatively, the enveloped P@T points at blue curves of Figure 1 to be considered fully qualified, as qualification targeting one of the other less restrictive operating scenarios informed shall greatly limit the possibility of supply.

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3.2 KEY VARIABLES

The following specific conditions of Table 4 shall be considered when planning the execution of the pre-qualification:

Table 4 – Key Variables.

Key Variable	Specific Conditions Requiring a New Qualification	Qualification Tests
I. Maximum overall temperature (1)	Product previously supplied or tested at overall maximum temperature below that of the scenarios	Sections 6, 7.3 and 8.2 of ref. [3]
II. Maximum overall pressure (1)	Product previously supplied or tested at overall maximum pressure below that of the scenarios	Sections 6 and 7.3 of ref. [3]
III. Minimum temperature (1)	Product previously supplied or tested for minimum temperature higher that of the scenarios	Sections 6.1 of ref. [3]
IV. Maximum overall cocking angle (1)	Product previously designed/tested for overall maximum cocking angle below that of the scenarios	Section 8.1 of ref. [3]
V. Mean operating conditions (1)	Product previously supplied or tested at either mean pressure and mean temperature below that of the scenarios of Table 3	Sections 6.2, 6.4, 7.1 and 7.3 of ref. [3]
VI. Material specification (elastomeric)	Change in material specification from previous test/ projects, or test results	Sections 6, 7.1 and 7.3 of ref. [3]
VII. Design specification (Bellow)	Change in material specification or geometry from previous test/ projects(2)	Section 7.2 of ref. [3]
	Nonuse of bellow barrier or the employment of different barrier type(2)	Sections 6.2, 7.1 and 7.3 of ref. [3]
VIII. Welding procedure (WoL)	Change in the welding procedure, or any of the essential variables listed in table C-2 of appendix C of ref. [1].	Section 7.4.1 and 7.4.4.2 of ref. [4]
	Consideration of the CRA layer strength contribution in design if not pre-qualified.	Section 5.3 of ref. [4]
	Absence of proper sulfide corrosion test results	Sec. 7.4.4.3 of ref. [4]
IX. NDT procedures // initial flaw size detection capability (WoL)	Change in the NDT procedure used for flaw detection and sizing in the weld overlay to a non-qualified/validated procedure.	Section 4-iv
	The initial flaw height, calculated as a non-detected full circumferential flaw in ECA, is lower than the PoD 90%|95% of the qualified NDT procedure used for the volumetric inspection of the WoL.	Section 6.15 of ref. [4]

(1) Based on Table 3 Conditions.
(2) Provisions of sec. 2.2–v shall be observed.

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3.3 ADDITIONAL DATA

Besides the information provided in Table 3, several additional data are also informed to allow INTERESTED PARTY to evaluate long–term endurance (sec. 3.3.1 to 3.3.3) and compatibility of internal parts with conveyed fluids (sec. 3.3.4).

3.3.1 Tension and Angle Time Series from Basic Design

Time series of tension and angle at the top of the riser (CoR) within the annex file *"(PROD1000) Time Series TA.7z"*.

There are 1193 time series' files associated with wave/wind/current directions with correspondent percentual of occurrence.

3.3.2 Transient Cycles of Pressure and Temperature (Temporary Events)

The transient flow condition applicable for all scenarios can be found in Table 5.

Table 5 – Transient Flow Conditions.

OPERATION	FLUIDS	TOP RISER PRESSURE (MPa)		DURATION (DAYS)	FREQUENCY (ANNUAL)
		(Families I, II & III)	(Family IV)		
i. Depressurization of the PO/SERV riser	Gas similar to that of the gas injection riser (high CO_2 content)	1.0	1.0	2	1
ii. Opening of the XO for the PO/SERV riser with pressurization of the production fluid	Gas similar to that of the gas injection riser (high CO_2 content) + Fluid from the production riser	15.0	15.0	3	1
iii. Bullheading of the PO/SERV riser fluid to the reservoir	Gas similar to that of the gas injection riser (high CO_2 content) + Production riser fluid or N2 + Production riser fluid	32.0	69.0	10	1
iv. Opening of XO for the PO/SERV riser and formation of hydrate in the service riser	Gas similar to that of the gas injection riser (high CO_2 content) + Fluid from the production riser	32.0	75.0	30	1
v. Passage of pig or diesel circulation with dirty gas	Gas similar to that of the gas injection riser (high CO_2 content) + Fluid from the production riser	20.0	45.0	0.5	4

3.3.3 Seawater Temperatures

The temperature at the isolation rubber coating shall be determined as per sec. 7.8 of

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ref. [4], for the temperature conditions of the scenarios described in Table 3. Seawater temperatures to be used in heat transfer analyses are:

- T_{AVG} = 23.5°C
- T_{MAX} = 25.5°C

3.3.4 Contaminant Composition in Conveyed Fluids

Table 6 presents the contaminant content of the conveyed fluids through the riser of scenarios I–II–A, III–A and IV–A, while Table 7 presents it for the scenarios I–II–B, III–B and IV–B.

Table 6 – Contaminant Content of Conveyed Fluids of Scenarios I–II–A, III–A and IV–A.

SCENARIOS	COMPONENT	CONCENTRATION	UNITY
I–A & III–A	CO_2	85	%
	H_2S	500	Ppmv
	H_2O	Presence of free water	-
II–A	CO_2	0 a 3	%
	H_2S	200	Ppmv
	H_2O	Presence of free water	-
IV–A	CO_2	0 a 3	%
	H_2S	10	Ppmv
	H_2O	Presence of free water	-

Table 7 – Contaminant Content of Conveyed Fluids of Scenarios I–II–B, III–B and IV–B.

SCENARIOS	COMPONENT	COMPOSITION	UNITY
I–B & III–B	Teor de H_2O	120	ppmv
	N_2	Fluid A – 0.81	% mol
		Fluid B – 0.08	
	CO_2	85	
	H_2S	500	ppmv
II–B	H_2O Content	40	ppmv
	N_2	Fluid A – 0.89	% mol
		Fluid B – 0.55	
	CO_2	3	
	H_2S	200	ppmv
IV–B	H_2O Content	40	ppmv
	N_2	Fluid A – 0.66	% mol
		Fluid B – 0.69	
	CO_2	3	
	H_2S	20	ppmv

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4 PRE-QUALIFICATION PLAN

i. INTERESTED PARTY shall primarily present a description of the equipment intended to be offered/qualified for PROD1000 Projects per Families for information. This information is relevant to complement the premises stated in items 2–iv, 2–v and 2–vi, in case qualification waivers referred to in item 4–ii are submitted, or to aid the evaluation of complementary technical qualification of new/ unchecked designs. Such description shall contain:

   a. Textual description preferably accompanied by schematic figure of the Flexible Joint and its main parts, as show in sec. 1.3 of ref. [4], for instance;

   b. Part list with material specification (standard, commercial designation) of the main components: Flexible Element (rubber and metal Reinforcement), large Forgings, Bellow and Thermal Barrier;

   c. Bellow description: inform whether bi–diameter bellow, other construction form/ material of bellow, or other type of primary barrier to prevent contact with conveyed fluids is used;

   d. Statement of Flexible Joint dimensional compatibility with any of PETROBRAS standard receptacle types of ref. [6], ref. [7] and ref. [8] (minimum compatible basket type) or basket minimum compactible dimension if greater (INFORMATIONAL).

   NOTE: General Arrangement drawing(s) of the qualified FXJ shall be prepared reproducing the information of Items *a* to *d* above, and reported as per item 5–vi.

ii. INTERESTED PARTY shall summarize the evidence for qualification waiver, if any, according to section 2.2–iv, for the key variables listed in Table 4. The comparison between the test/ project conditions and those related in this description report shall be clearly highlighted, with the justification for the test waiver request.

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iii. Whenever new qualification is required, according to the conditions presented in Table 4, the qualification requirements of the correspondent Key Variable I to IX, listed in this same table, shall be followed.

iv. Minimum test conditions shall be based in service parameters presented in Table 3, and the long–term loading data provided within sec. 3.3.1 and 3.3.2. Seawater temperature (sec. 3.3.3) and contaminant content in conveyed fluid (sec. 3.3.4) are given for information.

v. NDT procedure shall be proposed by INTERESTED PARTY to be submitted to PETROBRAS for review prior to the start of the tests. The qualification shall demonstrate the capability of the NDT procedure to detect flaw heights, calculated as a non-detected full circumferential flaw in ECA, equal to the PoD 90%l95% of the NDT procedure.

vi. The comparison between the planned test conditions and those related herein this Description Report, if deviate from the later, shall be clearly highlighted in the documentation.

vii. At the completion of the tasks, INTERESTED PARTY shall prepare a pre-qualification dossier containing the deliverables and minimum information indicated in sec. 5. Preliminary or partial reports should be prepared and submitted to PETROBRAS for review before the start of the tests. Partial results may be presented to PETROBRAS appreciation before the completion of each test.

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5 DELIVERABLES

The final pre-qualification dossier shall contain the following reports and information:

i. Description of the pre-qualified Flexible Joint, as per item 4–i.

ii. Summary of the planned test conditions correlating them with the scenarios of Table 3, comparing with the key variables and other conditions listed in sec. 3, or justification for any requested test waiver, whether applicable.

iii. Individual final test reports, as per qualification tests related in Table 4, containing test date, scope of the test, signature of third part, standard (if applicable), acceptance criteria and results.

   a. Preliminary test reports containing partial test results should be sent to PETROBRAS appreciation in advance.

iv. Test equipment calibration certificates and characteristics (reference, accuracy, range) shall be included in the report. Calibration certificates shall be valid at the time of the tests.

v. Photos demonstrating the test apparatus and specimens before and after the tests.

vi. General Arrangement drawing(s) of the offered FXJ for information, containing the main external dimensions (diameter, length overall, API flange elevation and maximum angular capacity of the Extension). Details mentioned in sec. 4–i shall be included. The graphical representation of the internal components may be omitted, but in this case the description of such parts requested in Item 5–i shall be sufficient to allow a comparison with the base case of sec. 1.3 of ref. [4]. In case different design (especially for the Bellow barrier) is proposed, the details shall be included in the General Arrangement drawing(s).

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