
	TECHNICAL SPECIFICATION	Nº: I-ET-0000.00-0000-295-P9U-001
	CLIENT: PETROBRAS	SHEET: 1 of 11
	PROGRAM: RIGID OFFSHORE PIPELINES	CC
	AREA:	PROJECT:
DP&T	TITLE: CALIPER PIG'S REQUIREMENTS	 EISE / EDR

INDEX OF REVIEWS

REV.	DESCRIPTION AND/OR AFFECTED PAGES
0	ORIGINAL
A	INCLUSION OF CENPES COMMENTS

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	26/12/2017	12/04/2018							
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EXECUTION	CSN4	CSN4							
CHECK	SG5H	SG5H							
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TECHNICAL SPECIFICATION	Nº I-ET-0000.00-0000-295-P9U-001	REV.: A
PROGRAM:	RIGID OFFSHORE PIPELINES	SHEET: 2 de 11
TITLE:	CALIPER PIG'S REQUIREMENTS	CLASSIF: CORPORATIVA
		GESTOR: EISE/EDR

CONTENTS

1	OBJECTIVE.....	3
2	REFERENCES.....	3
3	DEFINITIONS AND ABBREVIATIONS.....	3
4	GENERAL.....	4
5	GENERAL CALIPER PIG REQUIREMENTS.....	4
6	ACCEPTANCE CRITERIA	6
7	MINIMUM DATA FOR REPORTS.....	8
8	CONTINGENCY PROCEDURES	9
9	DOCUMENTATION AND DELIVERABLES	9

	TECHNICAL SPECIFICATION	Nº I-ET-0000.00-0000-295-P9U-001	REV.: A
	PROGRAM: RIGID OFFSHORE PIPELINES	SHEET: 3 de 11	
	TITLE: CALIPER PIG'S REQUIREMENTS	CLASSIF: CORPORATIVA	
		GESTOR: EISE/EDR	

1 OBJECTIVE

- 1.1 The objective of this specification is to establish the requirements for the Caliper Pigs inspection on the Construction of New Pipelines.

2 REFERENCES

- 2.1 DNVGL-ST-F101 - Submarine Pipeline Systems, 2013
- 2.2 DNVGL-RP-F115 – Pre-commissioning of submarine pipelines, 2016
- 2.3 Specifications and requirements for in-line inspection of pipelines - Version 2016. Pipeline Operators Forum
- 2.4 API 1163 – In-Line Inspection Systems Qualification, 2013
- 2.5 NACE RP0102 – In-Line Inspection of Pipelines, 2017

3 DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

- 3.1.1 CONTRACTOR: The company responsible for the dewatering, conditioning and nitrogen purging of subsea pipelines.
- 3.1.2 May: A course of action permissible within the limits of this specification (used when referring to CONTRACTOR).
- 3.1.3 Must not: Prohibited requirement (used when referring to CONTRACTOR).
- 3.1.4 Shall: Mandatory requirement (used when referring to CONTRACTOR).
- 3.1.5 Should: Preferred requirement (used when referring to CONTRACTOR)

3.2 Abbreviations

- 3.2.1 ID – Internal Diameter
- 3.2.2 N/A – Not Applicable
- 3.2.3 PLR - Pig Launcher and/or Receiver
- 3.2.4 POD – Probability Of Detection
- 3.2.5 POF - Pipeline Operators Forum



TECHNICAL SPECIFICATION	Nº I-ET-0000.00-0000-295-P9U-001	REV.: A
PROGRAM: RIGID OFFSHORE PIPELINES	SHEET: 4 de 11	
TITLE: CALIPER PIG'S REQUIREMENTS	CLASSIF: CORPORATIVA	
	GESTOR: EISE/EDR	

4 GENERAL

- 4.1 The Pre-Commissioning activity of one pipeline includes the inspection with a Caliper Pig. Prior to the pre-commissioning activity, CONTRACTOR shall issue the pre-commissioning procedure to PETROBRAS approval, which shall include information about the Caliper PIG specification (design manufacturer, technical data, drawings etc.), running procedure and the acceptance criteria, in compliance with this I-ET-0000.00-0000-295-P9U-001. No operation shall be started before approval of the procedures is obtained.
- 4.2 CONTRACTOR shall inform if the Caliper Pig running phase will be done before or after hydrotest.
- 4.3 CONTRACTOR shall submit to PETROBRAS, prior the pre-commissioning activity, the caliper pig certificate of calibration.
- 4.4 CONTRACTOR shall include in the pre-commissioning procedure the operation principle for the pig location system and its operational details. PETROBRAS will not accept the location done only by fluid's pressure and/or by flow monitoring along the pipeline.
- 4.5 CONTRACTOR to ensure that the pipeline is able to be inspected with the Caliper Pig.

5 GENERAL CALIPER PIG REQUIREMENTS

- 5.1 The caliper pig design shall take into account the local pressures and temperatures during pig running.
- 5.2 The caliper pig shall be capable to detect defects size and its position as per Table 1.

	Dent	Ovality
Ovality (ID reduction) accuracy at 90% certainty	NA	1% ID
Ovality (length) accuracy at 90% certainty	NA	10% ID
Depth sizing accuracy at 90% certainty	1% ID	N/A
Width sizing accuracy at 90% certainty	10% ID	N/A
Length sizing accuracy at 90% certainty	10% ID	NA

Table 1: Detection and sizing accuracy for dents and ovalities

$$OVALITY = \frac{ID_{max} - ID_{min}}{ID_{max} + ID_{min}}$$

5.3 The Caliper Pig used for the internal diameter range from 6 to 24 inches shall have at least the number of sensors presented in the Table 2 to reduce the failure probability.

Internal Diameter (in)	Minimum Number of Sensors
6	16
8	18
10	20
12	22
14 - 24	24

Table 2: Minimum number of sensors for pipelines internal diameter

5.4 In case of pipelines with internal coating or CRA layer, the material of pigs' odometers or any other part in contact with the internal surface of the linepipe shall be compatible with the internal coating or CRA layer in order to avoid any damage. No steel or metal parts is allowed to be in contact with the internal coating or CRA layer.

5.5 The caliper pig shall have a magnetic or electronic location device. The tracking system shall be able to locate the tool at a distance not greater than 15 meters.

5.6 The Caliper Pig shall be able to:

5.6.1 Record internal diameter along the entire pipeline length

5.6.2 Localization, identification and sizing of dents, ovalities, buckles, gouges, wrinkle and other anomalies.

5.6.3 Identify and localize accessories and components such as pipe flanges, valves, bend radius, branches and internal diameter changes along consecutive linepipes and circumferential welds.

5.6.4 The accuracy of the clockwise to the caliper pigs shall be equal or better than $\pm 10^\circ$.

5.6.5 The accuracy of distance to/from marker shall be equal or better than 0.25% of distance.

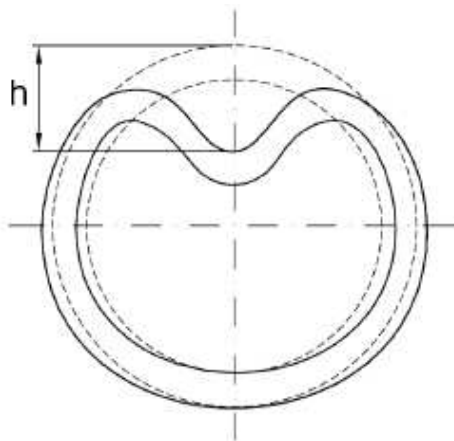
5.6.6 The accuracy of distance to closest weld shall be equal or better than 0.15 m.

5.7 Calibration of Caliper Pig and certificate. Caliper pig shall be calibrated by qualification tests developed in a pig loop that simulates the pipeline to be inspected. The calibration certificate shall be issued by CONTRACTOR, confirming that the equipment is calibrated and proper to use. The calibration certificate shall contain the tests reports performed during the calibration with its results and calibrating graphics, acceptance criteria and tests approval.

5.8 The geometric anomalies shall also be described using the length L (in the longitudinal direction base on KP of pipeline), width W (in the circumferential

direction based on hour position) and depth h (in the radial direction), where these parameters are applicable.

5.8.1 The depth h for dents is defined as the distance between the deepest point of the dent and the extension of the original diameter of the pipeline as shown in Figure 1. The dent can be expressed in absolute value or as a percentage of the nominal inside diameter. The length of each dent (along the pipeline) shall be detected and defined.



h: Dent depth

- Dashed Line – Original Cross section
- Continuous line – Deformed Cross Section

Figure 1: Dent Depth

5.8.2 Ovality shall be express mathematically by the following equation:

$$OVALITY = \frac{ID_{max} - ID_{min}}{ID_{max} + ID_{min}}$$

5.8.3 Where ID_{max} and ID_{min} means the maximum and minimum internal diameter, respectively, in the cross section considered.


5.8.4 Internal diameter variations, reductions or increases in the nominal value, when expressed as percentages, shall be calculated according to the following equation:

$$\text{Change (\%)} = \frac{ID_{nominal} - ID}{ID_{nominal}} \times 100\%$$


5.8.5 Where ID represents the minimum or maximum internal diameter observed in the cross section which are being analyzed when there is a reduction or increase related to the nominal internal diameter, respectively.

6 ACCEPTANCE CRITERIA

6.1 It will be considered a valid pig run when the maximum inspection loss along the pipeline length is 1:1000 or (0.1%). These data loss are to be considered as the sum of all sensors.

	TECHNICAL SPECIFICATION	Nº I-ET-0000.00-0000-295-P9U-001	REV.: A
	PROGRAM: RIGID OFFSHORE PIPELINES	SHEET: 7 de 11	
	TITLE: CALIPER PIG'S REQUIREMENTS	CLASSIF: CORPORATIVA GESTOR: EISE/EDR	

- 6.2 It will only be accepted up to 3 partial losses of channels, since they are not adjacent at the same crown.
- 6.3 The Caliper Pig shall be driven at speeds ranging from 0.2 to 2 m/s. It will be considered valid, pig running with a maximum inspection loss along the pipeline length of 1:1000 or (0.1%).
- 6.4 If the caliper pig run doesn't fulfill the acceptance criteria presented in this section, another caliper pig run shall be performed.
- 6.5 The caliper pig inspection shall register occurrences as defined in the section 5.6 of this I-ET-0000.00-0000-295-P9U-001 within the sensitivity limit of the inspection tool.
- 6.6 The following defects are unacceptable:
- 6.6.1 Ovality greater than 5% (difference between the largest and smallest external diameters measured in any pipe section divided by sum of largest and smaller diameter) in any extension;
- 6.6.2 Dents, with any extension, which produces reductions in diameter higher than those defined below:
- 6.6.2.1 2% of the diameter, for pipe with nominal diameter greater than 12";
- 6.6.2.2 0.25 inches, for pipe nominal diameter of 12" or smaller;
- 6.6.2.3 Diameter reductions of any dimension, which are stress concentrators, such as notches, punching, gouges and scratches;
- 6.6.2.4 Diameter reductions of any extension in welds which are greater than the approved welding procedure.

	TECHNICAL SPECIFICATION	Nº I-ET-0000.00-0000-295-P9U-001	REV.: A
	PROGRAM: RIGID OFFSHORE PIPELINES	SHEET: 8 de 11	
	TITLE: CALIPER PIG'S REQUIREMENTS	CLASSIF: CORPORATIVA	
		GESTOR: EISE/EDR	

7 MINIMUM DATA FOR REPORTS

7.1 The field report shall contain a statement of the CONTRACTOR on the quality of the data collected during the inspection. CONTRACTOR shall issue field report showing evidence that acquisition of data with caliper pig was successful in the entire length of the pipeline. The following information should be submitted:

7.1.1 Odometer final record based on KP of pipeline;

7.1.2 Graphic of pig speed versus time and average speed;

7.1.3 Graphic of pig speed versus distance (KPs);

7.1.4 Graphic of all sensors registration during pig running, since the pig launcher to the pig receiver, including all pipeline length;

7.1.5 Inspection data summary such as distance recorded by the inspection tool, average speed, date and time of launching and receiving of the pig;

7.1.6 Visual and photographic assessment of the caliper pig, before and after the running.

7.2 The caliper pig final report shall contain at least the following information:

7.2.1 Inspection company data

7.2.2 Identification of the pipeline section inspected

7.2.3 Calibration certificate number and expiration date

7.2.4 Date of inspection

7.2.5 Type of inspection

7.2.6 Length of the section inspected

7.2.7 Total number of dents

7.2.8 Total number of ovalities

7.2.9 Number of dents with depth > 2% ID and <6% ID


7.2.10 Number of dents with depth \geq 6% ID

7.2.11 Number of ovalities with ratio \geq 0.10

7.2.12 Location and orientation plot of all dents over the full pipeline length

7.2.13 Location and orientation plot of all ovalities over the full pipeline length

7.3 The caliper pig final report shall also have the field report information.

	TECHNICAL SPECIFICATION	Nº I-ET-0000.00-0000-295-P9U-001	REV.: A
	PROGRAM: RIGID OFFSHORE PIPELINES	SHEET: 9 de 11	
	TITLE: CALIPER PIG'S REQUIREMENTS	CLASSIF: CORPORATIVA	
		GESTOR: EISE/EDR	

7.4 The anomalies data shall include the following details:

7.4.1 Odometer absolute position of the anomaly

7.4.2 Distance between the greatest depth of the anomaly and the nearest circumferential weld

7.4.3 Wall thickness from the analyzed section

7.4.4 Maximum depth of anomaly

7.4.5 The maximum width and length of the anomaly

7.4.6 The location of the girth welds along the pipeline

7.5 The report shall include information about the pigability of the pipeline. CONTRACTOR shall also report the following information:

7.5.1 Ovality (greater than or equal to 5% of the nominal diameter of the pipeline);

7.5.2 Any dents greater than the values defined in the section 6.6.2;

7.5.3 Punching of pipeline;

7.5.4 Ambient temperature and pressure;

7.5.5 Minimum internal diameter;

7.5.6 All anomalies in circumferential welds' regions;

7.5.7 Total number of dents;

7.5.8 Total number of ovalities;

7.5.9 Datasheet and drawing of the caliper pig.


8 CONTINGENCY PROCEDURES

8.1 CONTRACTOR shall present contingency procedures for each situation, when necessary, and provide the required equipment and operations for these contingencies.

9 DOCUMENTATION AND DELIVERABLES

9.1 All observations shall be recorded on the appropriate forms stating clearly the event. Incomplete forms and absence of documentation should be a cause of a new operation.

9.2 CONTRACTOR shall present the Field Report to PETROBRAS within 2 days after the respective run.

	TECHNICAL SPECIFICATION	Nº I-ET-0000.00-0000-295-P9U-001	REV.: A
	PROGRAM: RIGID OFFSHORE PIPELINES	SHEET: 10 de 11	
	TITLE: CALIPER PIG'S REQUIREMENTS	CLASSIF: CORPORATIVA GESTOR: EISE/EDR	

9.3 CONTRACTOR is responsible for delivering of the Final Inspection Report to PETROBRAS within 60 calendar days, starting from the approval of the inspection.

9.4 The Final Inspection Report, with the compilation of the Field Report results, shall be presented in digital form (2 copies DVD), allowing video visualization and printing, proper for "Windows" operational systems.

9.5 The Final Report shall comply with the specifications and requirements of Ref. [2.3].

9.6 The raw data of all sensors and odometers (raw data are understood as the intensity of the signals of all sensors across the scans) shall also be provided to PETROBRAS.

9.7 The raw data of the sensors may be available only in the viewing application.

9.8 The viewing application of the inspection results shall work in Windows Seven operational system or superior. It shall work not requiring logon in the server where it is installed and shall be installed and function in the PETROBRAS corporate integrated network.

9.9 The files with the Inspection Results, which are read by means of the viewing application, shall also be installed and work in the PETROBRAS corporate integrated network.


9.10 The administration of the application shall not require the user to be the administrator of the operational system.

9.11 CONTRACTOR shall formalize by means of document the right to use the application in PETROBRAS network for an indefinite period of time.

9.12 The licensed software for use in network shall allow the installation of an unlimited number of computers and users.

9.13 The requirements of the items related to the use of the software shall be met before the delivery of the Inspection Report.

9.14 CONTRACTOR shall supply, at least, the following documents/deliverables:

	TECHNICAL SPECIFICATION	Nº I-ET-0000.00-0000-295-P9U-001	REV.: A
	PROGRAM: RIGID OFFSHORE PIPELINES	SHEET: 11 de 11	
	TITLE: CALIPER PIG'S REQUIREMENTS	CLASSIF: CORPORATIVA	
		GESTOR: EISE/EDR	

- 9.14.1 Caliper qualification trial reports;
- 9.14.2 Records of failures, if applicable;
- 9.14.3 Instruments certificates of accuracy;
- 9.14.4 Calibration certificates and reports;
- 9.14.5 Data sheets and caliper specification;
- 9.14.6 Drawings with the main dimensions and weight;
- 9.14.7 Drawings with the main the main components of the caliper;
- 9.14.8 Schedule of all operations;
- 9.14.9 Registers;
- 9.14.10 Pictures;
- 9.14.11 Tables;
- 9.14.12 Graphs;
- 9.14.13 Field report;
- 9.14.14 Final report;
- 9.14.15 Viewing application of the inspection results.