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## INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL
A	Item 3.1.17 updated
B	General Revision Added Definitions of Outer Sheath and External Protective Sheath

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G
DATE	18/12/2019	01/11/2021	31/07/2023					
PROJECT	SUB/ES/DCT	SUB/ES/DCT	SUB/ES/DCT					
EXECUTION	Walter (UQ9R)	Walter (UQ9R)	Walter (UQ9R)					
CHECK	Eder (CSN8)	Eder (CSN8)	Eder (CSN8) Gasparetto (BEJH)					
APPROVAL	Lancelotti (CXAX)	Lancelotti (CXAX)	Lancelotti (CXAX)					

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

FORMULÁRIO PADRONIZADO PELA NORMA PETROBRAS N-381-REV.L.

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## 1. General

This technical specification is based on Standard API Specification 17J Fourth Edition, 2014 (herein referenced as API 17J), and establishes additional requirements and modifications for supplying unbonded flexible pipes. All requirements of API 17J that are not altered herein are in force. If there is any conflict between API 17J and this document, this document shall prevail. Reference is also made to other normative documents as per Section 2.

Sections and subsections of this specification and its references from Section 4 to Section 10 refer directly to their counterpart in API 17J.

Project specific documentation may supersede the requirements herein when clearly stated. In case of doubt, please contact Petrobras regarding the specific project.

This specification should also be used by the manufacturers when developing prototypes and when evaluating flexible pipes, for installation and operation phases, including damaged and repaired pipes, although proper bridging between current and old requirements may be required. Testing activities should consider the recommendations presented in I-ET-3000.00-1519-291-PAZ-011 – Testing Requirements [10].

This specification covers the pipe concepts as described in API 17B. This document is not intended to cover the use of alternative concepts not described in API 17B or composite or hybrid flexible pipes.

New Pipe Designs and New Materials shall be qualified and accepted by Petrobras beforehand. Only pipe concepts described in the Design Methodology Review Certificate will be accepted. Only materials that have been certified by the IVA and approved by Petrobras shall be accepted.

Manufacturer, Product and Material qualification requirements are presented in document I-ET-3000.00-1519-291-PAZ-002 – Flexible Pipe Qualification [1].

As also stated for API 17J, “Users of this Specification should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein”. Therefore, if the due to its design methodology or IVA requirements, the manufacturer has to adopt safety or utilization factors different, more restrictive, from those presented in API 17J or herein, they shall be clearly stated in the Certification Documentation, Technical Proposal and Design Report. Less restrictive safety or utilization factors are not accepted.


## 2. References

### 2.1. Normative References

API Specification 17J, *Specification for Unbonded Flexible Pipe* (and associated documents).

Guide to the Expression of Uncertainties in Measurement, 1995. ISBN 92-67-10188-9, Corrected and reprinted – International Organization for Standardization (ISO).

### 2.2. Petrobras Documentation References

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- [1] I-ET-3000.00-1519-291-PAZ-002 – Flexible Pipe Qualification
- [2] I-ET-3000.00-1519-291-PAZ-003 – Flexible Pipe Certification Requirements
- [3] I-ET-3000.00-1519-291-PAZ-004 – General Functional Requirements
- [4] I-ET-3000.00-1519-291-PAZ-005 – Design Requirements
- [5] I-ET-3000.00-1519-291-PAZ-006 – Materials
- [6] I-ET-3000.00-1519-291-PAZ-007 – Manufacturing Requirements
- [7] I-ET-3000.00-1519-291-PAZ-008 – Documentation
- [8] I-ET-3000.00-1519-291-PAZ-009 – FAT
- [9] I-ET-3000.00-1519-291-PAZ-010 – Marking and Packaging
- [10] I-ET-3000.00-1519-291-PAZ-011 – Testing Requirements

### **3. Terms, Definitions, Acronyms, Abbreviations, and Symbols**


#### **3.1. Terms and Definitions**

##### **3.1.1.**

##### **Life Cycle (of a Flexible Pipe)**

The flexible pipe Life Cycle includes all phases of the flexible after it is manufactured, namely the phases listed below:

- a) Handling, reeling and unreeling;
- b) Factory acceptance tests;
- c) Stress relief of the pressure armor, in case the manufacturer's design methodology requires it;
- d) Storage;
- e) Installation;
- f) Offshore leak test;
- g) Early leak test;
- h) Operation
- i) Recovery.

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### 3.1.2.

#### **Natural Bending Radius**

The Natural Bending Radius is the minimum bending radius at which the pipe will move out of the bending plane.

### 3.1.3.

#### **Applicable failure modes and mechanisms:**

Applicable failure modes and mechanisms includes all failure modes or mechanisms as identified in API 17B, API 17J, Petrobras specifications or applicable failure mode analysis (FMEAs/FMECAs).

### 3.1.4.

#### **Independent Review Certificate (IRC)**

Certificate issued by the IVA for each pipe delivery certifying that that the specific product is adequate to operate as per the Type Approval Certificate limitations and that the design, material selection and manufacturing comply with certified methodologies.

### 3.1.5.

#### **Design Methodology:**

A consistent approach to the design of a component or system including the description of each design step and associated tools and the instruction on how to use them.

### 3.1.6.

#### **Design Tools:**

One or set of software, instruction, rule, program or any other kind of tool used within the design process of the manufacturer.

### 3.1.7.

#### **New Material:**

A new material is a material without a previous track record within Petrobras or a material which has not undergone full qualification and characterization testing.

### 3.1.8.


#### **Product:**

Product, as referenced herein, includes the flexible pipe structure and end fittings. For certification purposes, bend stiffener design shall also be considered as part of the product design methodology.

### 3.1.9.

#### **Range of Use:**

Boundaries within which a given design tool, material or manufacturing step is valid. Range of use may be specified in terms of pipe ID, type of profiles, material grades, laying angles, water

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depth, fatigue life, utilization factors, etc.

### 3.1.10.

#### Investigative Tests:

Experiments planned to evaluate unknown behavior, design premise, design methods, concepts and their sensitivity to product parameters and material properties.

### 3.1.11.

#### Development Tests:

Tests with the objective of verifying if the design concept and the manufacturing processes result in products that achieve the specified performance. Development tests are performed during product development to confirm premise or optimize product design.

### 3.1.12.

#### Product Qualification:

Process through which the manufacturer demonstrates, by means of technical evidence – analytical, numerical and/or experimental data – and Independent Verification Agent (IVA) certification – that the proposed product satisfies all the following requirements:

- it is designed using validated methodologies and tools, within the Design Methodology Verification Report.
- it achieves the expected performance in the required tests and engineering analyses, in accordance with the validated design methodology, and complies with the project requirements.

### 3.1.13.

#### Conventional Flexible Pipe

Un-bonded tubular body and end fitting concepts that follow the configuration of layers showed in API RP 17B and employ materials that comply with API Spec 17J and this specification.

### 3.1.14.

#### Non-Conventional Flexible Pipe

Concepts not included in the definition of Conventional Flexible Pipe, such as partially or fully bonded tubular bodies, pipe structures based on composite materials, or layers with corresponding functions other than those specified in API RP 17B.

### 3.1.15.

#### Type Approval

The Type Approval Certificate (TAC) is a more generic document issued by IVA containing the ranges of application of the manufacturer design tools and methodologies and manufacturing processes. For the purpose of this document, Type Approval Certificate is the same as the Design Methodology Verification Report defined in API 17J.

### 3.1.16. H<sub>2</sub>S Proportional Flowrate

The H<sub>2</sub>S flowrate in the annulus divided by the total metallic surface area that is exposed to this permeated H<sub>2</sub>S. Unit: (ml H<sub>2</sub>S/min)/cm<sup>2</sup>.

### 3.1.17. Material Batch (metallic materials)

A Material Batch (see Figure 1) shall be considered as a set of materials with identical:

- a) Specification;
- b) Primary casting;
- c) Forming process; and
- d) Post-forming heat treatment (e.g. patenting and quenching), and stress relief treatments (e.g. tempering), when applicable.

If deemed necessary, the pipe manufacturer may include additional parameters to those previously mentioned, for Batch definition.

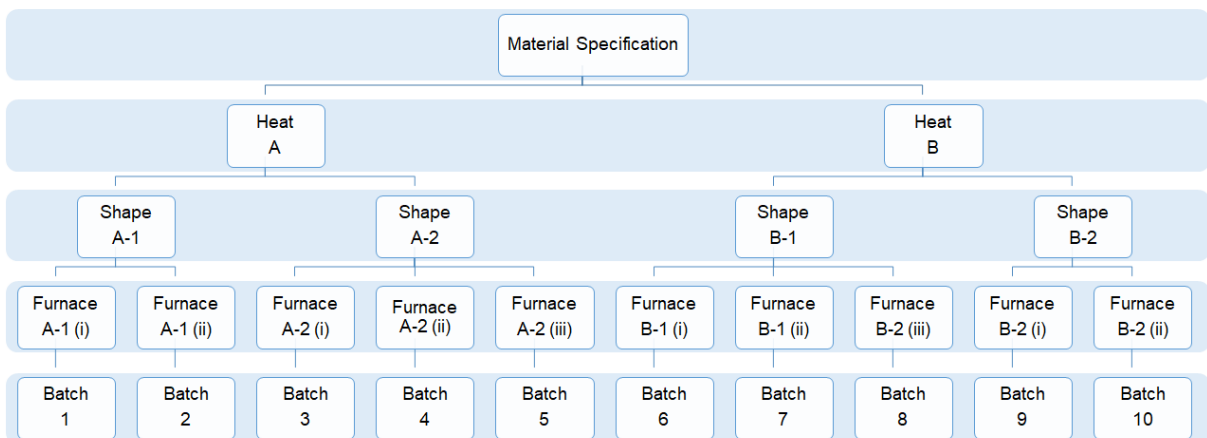



Figure 1: Batch definition

The following notes apply to the definitions in Figure 1:

- Specification refers to the manufacturer's specification for metallic materials as per Table 18 of section 6.3.2 of API Spec 17J:2014;
- Heat refers to the primary casting of the metal;
- Shape considers all processes (e.g. hot rolling, cold drawing, cold rolling and intermediate heat treatments) that lead to the wire final shape;
- Furnaces refers to all post-forming heat treatments applied to the wires.

For processes with continuous (in-line) heat treatment, a material Batch is defined as the equivalent length of 60 tons of wire. If a manufacturing run is shorter than the equivalent of 60 tons, it shall be considered as one Batch. Alternatively, the manufacturer may obtain samples

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after every 60 tons of continuous heat treatment and test, at the end of the run, the set with the highest hardness.

### **3.1.18. Outer Sheath**

Polymeric layer for protection of the annulus environment and of the metallic armors against external environment, reinforced or not by an external protective sheath.

### **3.1.19. External Protective Sheath**

Polymeric layer extruded over the outer sheath, tapes or over the insulation layer in order to protect the underlying layers against damage during pipe handling, installation or operation.

## **3.2. Acronyms, Abbreviations, and Symbols**

## **4. Functional Requirements**

The additional general functional requirements are presented in document I-ET-3000.00-1519-291-PAZ-004 – General Functional Requirements [3].

The specific functional requirements are presented in the project specific documentation.

## **5. Design Requirements**

The additional design requirements are presented in document I-ET-3000.00-1519-291-PAZ-005 – Design Requirements [4].

## **6. Materials**

The additional material requirements are presented in document I-ET-3000.00-1519-291-PAZ-006 – Materials [5].

## **7. Manufacturing Requirements**


The additional manufacturing requirements are presented in document I-ET-3000.00-1519-291-PAZ-007 – Manufacturing Requirements [6].

## **8. Documentation**

The additional documentation requirements are presented in document I-ET-3000.00-1519-291-PAZ-008 – Documentation [7].

## **9. Factory Acceptance Tests (FATs)**



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The additional FAT requirements are presented in document I-ET-3000.00-1519-291-PAZ-009 – FAT [8].

## 10. Marking and Packaging

The additional marking and packaging requirements are presented in document I-ET-3000.00-1519-291-PAZ-010 – Marking and Packaging [9].

## 11. Certification Requirements

Document I-ET-3000.00-1519-291-PAZ-003 – Flexible Pipe Certification Requirements [2] presents specific requirements for the scope of work and associated documentation to be issued by the IVA.

## 12. Testing Requirements

The testing requirements are presented in document I-ET-3000.00-1519-291-PAZ-011 – Testing Requirements [10].