

	TECHNICAL SPECIFICATION		Nº: I-ET-3010.00-1200-940-P4X-001							
	CLIENT:								SHEET 1 of 6	
	JOB:								--	
	AREA:									
SRGE	TITLE: POLYMERIC MATERIAL FOR CRITICAL GAS SYSTEMS							INTERNAL		
ESUP										
MICROSOFT WORD / V. 2010 / I-ET-3010.90-1200-940-P4X-001_B.DOCX										
INDEX OF REVISIONS										
REV.	DESCRIPTION AND/OR REVISED SHEETS									
0	ORIGINAL ISSUE									
A	GENERAL REVISION									
B	REVISED REFERENCE DOCUMENTS									
	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H	
DATE	AUG/29/18	JUL/02/20	APR/19/21							
DESIGN	ESUP	ESUP	EEA							
EXECUTION	FABIANA	MMARROIG	CJH4							
CHECK	MMARROIG	REUTHER	CJX4							
APPROVAL	JUVENTINO	GONZALEZ	U32N							
INFORMATION IN THIS DOCUMENT IS PROPERTY OF PETROBRAS, BEING PROHIBITED OUTSIDE OF THEIR PURPOSE.										
FORM OWNED TO PETROBRAS N-0381 REV.L.										

1 OBJECTIVE

1.1. This technical specification establishes requirements for selection and qualification of polymeric materials to be used at valves and compressor seals of FPSO units.

1.2. This Technical Specification does not intend to list every test necessary to qualify a given polymeric sealing material - within the equipment to be supplied - related to applications of critical gas systems. The valve or seal supplier shall guarantee its own quality procedure in order to manufacture its equipment, assuring its suitability for the service application described by the purchaser: i.e., considering compatibility with service environment, functionality under service and the design lifetime.

1.3. The tests described in this Technical Specification intend to cover some qualification tests, considered as pre-screening tests, in order to select a polymeric seal that is suitable for applications in critical gas systems.

1.4. This Technical Specification describes general principles and gives requirements and recommendations for selection and qualification of non-metallic materials for critical gas systems service in oil and gas production environments.

- a) By critical gas systems, it comprises:
- b) CO₂ compression / injection systems with pressures higher than 900 psi or supercritical CO₂ environment;
- c) Valves and instruments which subjected to high pressures gas (higher than 900 psi) or supercritical CO₂ environment;
- d) Equipment subjected to high pressures gas (higher than 900 psi) or supercritical CO₂ environment.

2 NORMATIVE REFERENCES

2.1 CODES AND STANDARDS

The following codes and standards include provisions which, through reference in this text, constitute provisions of this specification. The latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used, provided it can be shown that they meet or exceed the requirements of the standards referenced below.

- ISO 11346 Rubber, vulcanized or thermoplastic -- Estimation of life-time and maximum temperature of use
- 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
- ISO 23936-1 Petroleum, petrochemical and natural gas industries. - Non-metallic materials in contact with media related to oil and gas production. Part 1: thermoplastics
- ASTM D 746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
- ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.



2.2 DESIGN SPECIFICATIONS

DR-ENGP-M-I-1.3

Safety Engineering

I-ET-3010.00-1200-940-P4X-002

General Technical Terms

2.3 PROJECT SPECIFICATION

[PIPING SPECIFICATION FOR TOPSIDE]

[PIPING SPECIFICATION FOR HULL]

3 DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

All Terms and definitions are established in the latest revision I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS, and ISO 23936-1/2:

LINING: Lining means a coating or layer of sheet metal adhered to or in intimate contact with the interior surface of a base metal. Its function is to meet requirements such as corrosion resistance or abrasion at different working temperatures.

COATING SYSTEM: The complete number and types of coats applied to a substrate in a predetermined order.

4 FUNCTIONAL REQUIREMENTS

4.1. Polymer selection shall be based on evaluation functionality under service.

4.2. The service conditions for valves shall be based on **PIPING SPECIFICATION FOR TOPSIDE** and **PIPING SPECIFICATION FOR HULL**, issued during the Design.

4.3. For other equipment, the equipment purchaser shall be based on project information about service conditions and environment.

4.4. The selection shall according to the criteria of ISO 23936 part and part 2.

4.5. The following requirements are mandatory for selection of elastomeric sealing materials.

- a) Adequate physical and mechanical properties;
- b) Resistance against RGD events in accordance with ISO 23936. Rapid gas decompression testing is required for any pressure system with pressures higher than 900 psi.
- c) Long-term behaviour in accordance with ISO23936
- d) Resistance to high pressure extrusion or creep
- e) Resistance to thermal cycling, and dynamic movement;
- f) Low temperature flexibility, ASTM D 746 and ASTM D 790 (in any case of minimum design temperature lower than zero degree centigrade).

4.6. Samples to be exposed to experimental program shall be representative of the ones to be used in actual equipment considering polymer family and grade as well as production processing, curing process – for elastomers) route.

4.7. Decompression rate and number of cycles to be adopted for RGD shall be the ones standardized in ISO 23936 as a minimum. If decompression rates and number of cycles to which the seals are expected to be exposed to in the equipment, within its lifetime, are higher than the ones in the standard, those shall be chosen in order to be representative of actual equipment operation.

4.8. Prior to ageing and RGD cycles, material has to be properly soaked with representative fluids as discussed in the following sections, considering different diffusion times depending on polymer class (elastomer or thermoplastic).

4.9. RGD scenario, i.e. absolute pressure, absolute temperature and fluid composition (amount of CO₂, CH₄ and H₂S), shall be chosen so that they are fully representative (or more conservative than) actual equipment operation. Absolute pressure (rather than relative values) is to be used as reference.

4.10. RGD cycles shall be performed from chosen target pressure down to ambient pressure, unless actual equipment operation irrefutably occurs between a pressure variation above ambient pressure.

4.11. Thermoplastic materials shall also be evaluated for RGD performance using methodology proposed in ISO 23936-2 as reference and complementary requirements presented herein. For these, criteria is the absence of blistering, slits, voids or any unusual feature that can represent a previously non-existent stress concentrator. Inspection of thermoplastic seals shall be performed through microtomography using a resolution close to 10-12,000 micrometres.

4.12. Polymer selection shall take into account that, during RGD events, rapid pressure is accompanied by temperature drop (Joule-Thompson Effect), which is of particular importance when seal operation temperature is already low. In such sense, low temperature seal selection main aspects shall be considered.

4.13. Especially seals that operate at lower temperatures may behave more rigidly, leading to a potential complete fracture mode during RGD events rather than just blistering formation. As attested by ISO 23936-2, very stiff (often high hardness) compounds may resist bubble inflation but are less able to prevent crack propagation, in case initiation occur.

4.14. According to ISO 23936-2, “successful testing at particular values of temperature and pressure will automatically qualify the material for use in applications where the service temperature and pressure lie below these values” but only if failure mechanisms and modes are proven to be the same.

4.15. Seal confinement in the equipment shall be reproduced in sample holder in terms of, for instance, groove-fill and squeeze values, in order to guarantee representativeness. Standard values for groove-fill and squeeze provided in ISO 23936-2 may be used as reference if actual equipment is proven to present more conservative values, given limitations suggested by Annex F of ISO 23936-2. The absence of information regarding seal confinement in the actual equipment shall require the RGD evaluation of unconstrained samples which is a conservative approach.

4.16. Ageing scenario, i.e., absolute pressure, absolute temperatures and fluid composition (amount of CO₂, CH₄ and H₂S as well as oil/water) shall be considered in order to be similar to or more conservative than the actual operation conditions for the equipment. Acceptance criteria proposed in ISO 23936 shall be used for initial guidance only, given that equipment design and material properties limits of the seals in the actual equipment are responsibility of the manufacturer.

4.17. Especially for dynamic seals, despite no clear acceptance criteria is proposed in ISO 23936 for compression set, acceptance upper limits shall be clearly confirmed by manufacturer depending on the design and application of the equipment of interest in the target scenario.

5 ISO 23936-2 / ANNEX A – AMENDMENTS

Modification to ANNEX A: Test media, conditions, equipment and procedures for ageing of elastomeric materials

A.1.2.1 The temperatures for the immersion (ageing test) shall be the maximum and minimum design temperature.

A.1.2.2. The pressure shall be as close as possible to the operational pressure described in the design data. Attention shall be paid in relation to the state of the mixture CO₂ - CH₄: supercritical or gaseous depending on the pressure and temperature, because this must be reproduced in the immersion test.

A.1.2.3: The exposure period for lifetime predictions shall take account the time to reach saturation of the test samples (soak) and be sufficiently long as to allow for reliable extrapolation according to requirements for methods such as Arrhenius plot (**ISO 11346**).

6 ISO 23936-2 / ANNEX B - AMENDMENTS

Modification to ANNEX B: Test media, conditions, equipment and procedures for rapid gas decompression testing of elastomeric materials.

Test temperature: The test shall be conducted at the maximum design temperature if above 100°C. If the polymer may operate in low temperature, an additional test shall be performed.

Test pressure: The test shall be conducted at a representative operational pressure or 15Mpa the higher.



TECHNICAL SPECIFICATION	Nº I-ET-3010.00-1200-940-P4X-001	REV. B
		SHEET 6 of 6
TITLE: POLYMERIC MATERIAL FOR CRITICAL GAS SYSTEMS		INTERNAL
		ESUP

7 EQUIPMENT PURCHASER OBLIGATIONS

7.1 GENERAL REQUIREMENTS

7.1.1. The EQUIPMENT PURCHASER is responsible for the compliance with the requirements of the applicable International Codes, Statutory Regulations and the PETROBRAS Specification(s).

7.1.2. Any deviation from this Specification or any of the documents listed below may be accepted only after approval from the PETROBRAS.

7.2 CERTIFICATION REQUIREMENTS

7.2.1. EQUIPMENT PURCHASER shall be responsible for obtaining all necessary certification.

7.2.2. All tests shall be conducted by independent third party.

7.2.3. The test reports shall show at minimum:

- Identification of the polymeric material tested;
- Batch lot identification;
- Identification of the entity responsible for conducting tests;
- Responsible for conducting the tests;
- Test results according this Technical Specification;
- Conclusion;
- Standards used during tests.