PTT Exploration and Production Public Company Limited

PTTEP Engineering General Specification

PEGS

Gaskets for Piping and Vessels

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1.0 PURPOSE

The purpose of this General Specification is to specify general and fundamental requirements, rules and procedures for the procurement of gaskets assuring technical integrity and fitness of purpose with optimum life cycle cost.

2.0 SCOPE

This specification provides detailed requirements to supplement those specified in the individual piping material classes/ vessel datasheets and covers technical requirements for the fabrication, inspection, and shipment of cut-out flat gaskets, spiral-wound gaskets, and ring joints used for valves, vessels and piping flanges.

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3.0 DEFINITIONS

A number of different terms are commonly used to describe the work stages, processes, and approvals which take place during the early stages of a development. This can often be a source of confusion so the following section is intended to show the PTTEP preferred terminology as used in this document.

3.1 LANGUAGE

In this document, the words should and shall have the following meanings:

Should	Indicates a preferred course of action. Should is a non-mandatory word and is not forbidden, but use in the body of the text should be the exception. Where none mandatory terms are used, each paragraph within these clauses shall also have an associated commentary paragraph that provides the rationale for why the stated choices and modifications are appropriate and circumstance under which the stated choices and modifications might be different.
Shall	Indicates a course of action with a mandatory status. The term “shall” shall be used if a requirement is considered to be necessary to claim compliance with a PEGS document.

3.2 TERMINOLOGY

Terminology	Description
Approval	The authorization in writing given by the COMPANY to the Contractor on a procedure or to proceed with the performance of a specific part of the work without releasing in any way the Contractor from any of his obligations to conform with the technical specifications, requisitions, etc. The words “Approve”, “Approved” and “Approval” shall be construed accordingly
COMPANY	PTT Exploration and Production Public Company Limited and its subsidiaries
Contractor	Per contract: Contractor – ‘The Contractor who is a party to this contract and where the context so requires, any and all subcontractors utilized by Contractor for the performance of the work
Manufacturer	The company or its sub-contractor(s) selected by the COMPANY or the Supplier (as applicable) as the Manufacturer(s) of the said materials.
Supplier	The company or its agents designated on the Purchase Order or contract as being the selected Supplier of the said materials.

3.3 COMMON ACRONYMS

Set out below in alphabetical order are common acronyms as found within this document:

ASME	The American Society of Mechanical Engineers
ASTM	The American Society for Testing and Materials
CAF	Compressed Asbestos Fibre
CRA	Corrosion Resistant Alloy
DIN	Deutsches Institut für Normung (German institute for standardization)
EN	European Standard
IEC	International Electrotechnical Commission

ISO	International Organization for Standardization
m	Maintenance Factor: a factor that provides the additional preload needed in the flange fasteners to maintain the compressive load on a gasket after internal pressure is applied to a joint.
ppt	Parts per Thousand
PTFE	Polytetrafluoroethylene (Teflon)
Y	Minimum Design Seating Stress: the minimum compressive stress in pounds per square inch (or bar) on the contact area of the gasket that is required to provide a seal at an internal pressure.

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4.0 REFERENCES

The reference documents listed below, including Industry Codes and Standards and COMPANY specifications, form an integral part of this Engineering General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published on the effective date of a contract.

The overall order of precedence of the applicable documents shall be:

1. Applicable Laws, Rules and Regulations of the country in which the system/equipment will be operated (if any);
2. Purchase Order/ Service Order/ Contract Documents (Only applicable for direct purchase by COMPANY);
3. Project Particular Specification (PPS), and relevant data sheet(s) if any;
4. COMPANY General Specification;
5. Codes and Standards in reference.

Any conflict between any of the Contract Documents, or between this specification and any other Contract Documents, shall be reported to COMPANY for decision. In such a case, and unless otherwise agreed or decided by COMPANY, it is understood that the more stringent requirement shall apply.

Exceptions to, or deviations from this specification are not permitted unless previously accepted in writing by COMPANY. For this purpose, requests for substitutions or changes of any kind shall be completed with all pertinent information required for COMPANY assessment. COMPANY's approval, nevertheless, will not, in any way, relieve the responsibility of the Contractor to meet the requirements of the industry Codes and Standards referred to and amended herein, in the event of conflict.

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4.1 PTTEP INTERNAL REFERENCES

Internal documents applicable to this document are indicated in the table below.

Document Number	Document Title
PEGS-12060-ADM-006	Quality Requirements for Contractor/ Vendor
PEGS-12059-PIP-005	Pipes, Flanges, Fittings and Bolting for Piping
PEGS-12059-PIP-007 (*)	Piping Material Classes

(*) The second place (e.g. 0710) and third place (e.g. PIP) in document number refers to Custodian Department code and document discipline/ category respectively. As a result of re-organization, department code numbers have been changed and there is possibility of revising the document category (e.g. PIP) as well. Considering this, these PEGS's will be revised in due course. Hence, Contractor/ user of this PEGS shall refer to the latest PEGS available at the time of contract award.

4.2 INTERNATIONAL STANDARDS

International standards applicable to this document are indicated in the table below i.e. ISO, IEC or ITU.

Document Number	Document Title
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
ISO/TS 29001	Petroleum, Petrochemical and Natural gas industries – Sector – specific quality management systems – Requirements for product and service supply organizations

4.3 INDUSTRY CODES AND STANDARDS

Codes, standards and regional legislation applicable to this document are indicated in the table below.

Document Number	Document Title
API SPEC Q1	Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry
ASME B16.20	Metallic Gaskets for Pipe Flanges - Ring-Joints, Spiral-Wound, and Jacketed
ASME B16.21	Non-metallic Flat Gaskets for Pipe Flanges
ASME B16.47	Large Diameter Steel Flanges (NPS 26 through NPS 60)
ASME B16.5	Pipe Flanges and Flanged Fittings (NPS ½ through NPS 24)
ASME B31.3	Process Piping
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials
ASTM F146	Standard Test Methods for Fluid Resistance of Gasket

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Document Number	Document Title
	Materials
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F36	Standard Test Method for Compressibility and Recovery of Gasket Materials
DIN 3535-6	Gasket for Gas Supply – Part 6: Gasket Materials based on Fibres, Graphite or Polytetrafluoroethylene (PTFE) for Gas Valves, Gas Appliances and Gas Mains
DIN 52913	Testing of static gaskets for flange connections - Compression creep testing of gaskets made from sheets
EN 10204	Metallic Products - Types of Inspection Document

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5.0 REQUIREMENT FOR GASKETS FOR PIPING AND VESSELS

5.1 DESCRIPTION OF MATERIALS

5.1.1 GENERAL

Asbestos containing gaskets are prohibited.

Graphite impregnated flat gasket shall not be used with CRA (Corrosion Resistant Alloy) material (when in contact with a medium containing salty water, i.e. with salinity higher than 30 ppt) to avoid potential risk of crevice corrosion.

5.1.2 CUT OUT FLAT GASKETS

5.1.2.1 SYNTHETIC RUBBER GASKETS

The gaskets shall be made from neoprene fabric or equivalent.

5.1.2.2 OTHER FLAT GASKETS

Flat gaskets are subject to the COMPANY prior approval. The approval is based on the following requirements:

1. PTFE or PTFE based materials are not acceptable.
2. Only fiber-based materials or flexible graphite materials will be considered for the qualification.
3. Gasket material shall be qualified by type testing as mentioned in Appendix 1 and qualification shall remain valid for six years from the date of testing. Qualification may be revoked before six years period in case of adverse findings observed in the meantime on material testing performed by COMPANY on actual supplied material.
4. Material data sheet shall be submitted prior to starting the qualification test. It shall include the following:
    a. The colour coding of the two faces and the Manufacturer marking of the two faces of the product that identify plainly and durably the product. In case such colour coding or Manufacturer marking of a product can vary for any reason from a production unit to another, then only products identical to the one qualified will be allowed for further use.
    b. All information relating to the graphite quality, impurities and maximum contents of these for flexible graphite materials.
    c. Characteristics of inserts in flexible graphite materials or characteristics of metallic reinforcement in fiber based materials if any.

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5. The material data sheet shall also include the following mechanical characteristics for the two reference thickness 2 mm and 3 mm.
    a. The tensile strength (according to ASTM F152) of the gasket material shall be at least 16 N/mm^2.
    b. The compressibility of the gasket material measured according to ASTM F36, Procedure A shall be at least 8%
    c. The elastic recovery of the gasket material according to ASTM F36, Procedure A shall be at least 55%.
    d. The relaxation stress (according to DIN 52913, short term test) of the gasket material shall be at least 30 N/mm^2 (ideally, a minimum of 36 N/mm^2), and the thickness decrease shall not exceed 15% under a constant compression stress of 50 N/mm^2 @ 300°C.
    e. The thickness increase under immersion test in ASTM F146 oil no. 3 @ 150°C for 5 hours shall not exceed 15%. Additionally, the thickness increase under immersion test in ASTM F146 Fuel A @ 20°C for 5 hours shall not exceed 3%, and the thickness increase under immersion test in ASTM F146 Fuel B @ 20°C for 5 hours shall not exceed 8%.
    f. Maintenance Factor (m) and Minimum Design Seating Stress (Y) evaluation as per applicable standard.
6. The inserts in flexible graphite materials, gaskets or sheets to be cut to size, must be in one piece without any weld.
7. Cutting of flexible graphite sheets or reinforced fiber based materials shall be carried out by water jet means followed by an adequate heat treatment or by mechanical tools and procedure specially developed or approved by the gasket Manufacturer; other mechanical tools are prohibited.
8. The thickness of the gasket material shall be strictly identical to the thickness of the equivalent CAF gasket as shown on the relevant COMPANY piping material classes (i.e., 2 or 3 mm, depending on diameter).
9. Gas permeability (according to DIN 3535-6): ≤ 0.5 ml/mn.
10. Gasket faces shall receive on both sides an anti-sticking coating which shall receive the prior agreement of the COMPANY.

If reference is made to the ASTM F104 for a proposed gasket material, the classification shall be: F 702100 E03 M7 together with the additional requirements listed in above paragraphs of this section (which are not covered in the standard ASTM F104).

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5.1.3 SPIRAL-WOUND GASKETS

The gaskets shall be in accordance with the standard ASME B16.20 and their spiral-wound portion shall be made from type 316 stainless steel strip (or higher grade, depending on the relevant piping material specification).

The prior approval by the COMPANY shall be based on the following: The requisitions shall indicate the nature of the packing of the filling.

- PTFE or PTFE based materials are acceptable
- Graphite based fillers shall incorporate an adequate corrosion inhibitor which shall itself receive the COMPANY prior approval in order to prevent from possible galvanic corrosion.

The gaskets shall have an external centering ring and an inner ring. The two rings are made of either an epoxy-polyester coated carbon steel or of stainless steel (i.e., made of the same metallic material as for the stainless steel strip spires). In case of epoxy-polyester coating, the coating quality shall satisfy the following criteria

- The finished thickness shall be between 60 µm and 100 µm
- There shall be one coat only
- Testing shall be made on one test coupon per batch for the following:
    - Adhesion
    - Impact
    - Corrosion resistance.

Testing methods and acceptance criteria shall be proposed to COMPANY by the Manufacturer and agreed on by COMPANY prior ordering.

5.1.4 METAL RING JOINTS

Metal ring joint gaskets shall have following maximum Brinell hardness:

- Soft Iron : 90 HB
- Alloy steel : 130 HB
- 18/8 Stainless Steel : 135 HB

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5.2 DIMENSION

5.2.1 CUT OUT FLAT GASKETS

5.2.1.1 SYNTHETIC RUBBER GASKETS

The gaskets shall be 3 mm thick for diameters up to 6" and 5 mm thick for diameters 8" and over.

5.2.1.2 OTHER FLAT GASKETS

Materials (approved by the COMPANY), shall have dimensions including the gaskets thickness identical to those of the CAF gaskets which they are intended to replace.

5.2.2 SPIRAL - WOUND GASKETS

The dimensions of spiral-wound gaskets used on raised contact faces shall be in accordance with the standard ASME B16.20.

5.2.3 METAL RING JOINT

Ring joints shall be of octagonal type. The dimensions of ring joints shall be in accordance with the standard ASME B16.20, and shall be specified to match with the relevant flanges standard.

5.2.4 SPECIAL GASKETS

For all other types of gasket, or gaskets of dimensions greater than the limits defined by the reference standards, the Manufacturer shall submit a dimensioned document to the COMPANY for prior approval.

5.3 QUALITY CONTROL

The inspection and tests necessary to confirm that the products meet the requirements of the standards, specifications, and requisitions, shall be carried out in the Manufacturer's plant by personnel of the plant. This specially qualified personnel shall be independent of the production department of the plant.

Products shall be guaranteed by an inspection certificate (conformity, material, etc.) that must accompany the supply. If the Manufacturer does not have the necessary means of examination, these tests may be carried out by an Inspection Agency and at a place approved by the COMPANY.

All activity associated with quality requirements to be performed by Vendor for supply to the COMPANY shall comply with PEGS-12060-ADM-006 (Quality Requirements for Contractor/ Vendor)

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5.4 MANUFACTURER'S DOSSIER

5.4.1 CERTIFICATE OF CONFORMITY

The Manufacturer shall submit certificates of conformity to the standards specified by the requisitions for cut-out gaskets, spiral-wound gaskets, and metal ring joints.

5.4.2 MATERIAL CERTIFICATES

All tests shall be performed by ISO/IEC 17025 certified laboratories having accreditation for the required test methods.

The Manufacturer shall submit material certificates in accordance with the requirements of the reference codes and standards. Spiral wound gasket, RTJ gaskets, and metallic gaskets shall be certified in accordance with EN 10204 Type 3.1. For non-asbestos flat gaskets certification shall be in accordance with EN 10204 Type 2.2.

5.5 PREPARATION FOR SHIPMENT

5.5.1 MARKING

5.5.1.1 CUT-OUT FLAT GASKETS

A label grouping several gaskets of the same type shall indicate:

- The Manufacturer's name and trademark
- The diameter
- The rating
- The Material.

5.5.1.2 SPIRAL-WOUND GASKETS

In addition to the marking required by the standard ASME B16.20, the following information shall be marked by cold stamping on the centering ring of each spiral-wound gasket:

- The Manufacturer's name and trademark
- The diameter
- The rating.

5.5.1.3 METAL RING JOINTS

In addition to the marking required by the standard ASME B16.20, the outside surface of each ring shall include the following information which shall be marked by cold stamping:

- The Manufacturer's name and trademark
- The diameter

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- The rating
- The ring number, followed by the identifying reference of the material.

5.5.1.4 PROTECTION

Ring joint gaskets other than those made of stainless steel shall be covered by grease-impregnated protecting strips.

Small diameter gaskets shall be grouped in cardboard boxes or plastic pouches and large-diameter gaskets in rigid packing cases.

5.5.1.5 PACKING

The gaskets must be packed in sea-packing, which must be tight and meet the requirements of all stages of transport (rail, road, air, etc.).

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6.0 APPENDICES

Appendix 1. Qualification of Non Asbestos Flat Gaskets – Type Testing Procedure

1. Scope

This procedure defines the tests required for the qualification of non-asbestos flat gaskets usually used by the COMPANY in piping systems of pressure class 150 and 300. The purpose of this qualification procedure is to evaluate the mechanical properties of the gaskets together with their sealing behavior in flange assembly.

Some applications can need additional tests to confirm that these gaskets are fit for use.

2. Gaskets, material and characteristics

The gaskets are of fiber type or flexible graphite compound. The gaskets must conform to

ASME B16.21 for their dimensions. The gaskets used for testing are delivered in two sizes: 8" in 2 mm thickness and 16" in 3 mm thickness.

3. Testing equipment

All tests shall be performed in testing laboratories approved by the COMPANY.

These laboratories must be qualified under ISO/IEC 17025 – General Requirements for The Competence of Testing and Calibration Laboratories. All tests shall be performed inside closed premises. The qualification procedure relating to one material shall be performed entirely in the same laboratory.

The testing premises shall be equipped with the following main equipment:

- Press (10 kN, 500 kN, 2000 kN and 5500 kN)
- Helium mass spectrometer (10^{-9} to 10 atm.cm^3/s)
- Pressure controller (up to 100 bar)
- Testing platens, with plain faces or raised faces. The finish of contact faces of the testing platens, plain faces or raised faces shall correspond to a “stock finish” surface condition: Ra value between 6.3 µm and 12.5 µm and Rt value of 30 µm.
- 8" and 16" pressure class 300 flanges as per ASME B16.5 with raised faced finish
- Instrumented Rods in size M33
- Hydraulic bolt tensioners
- All time scaled tests shall be data-logged throughout.

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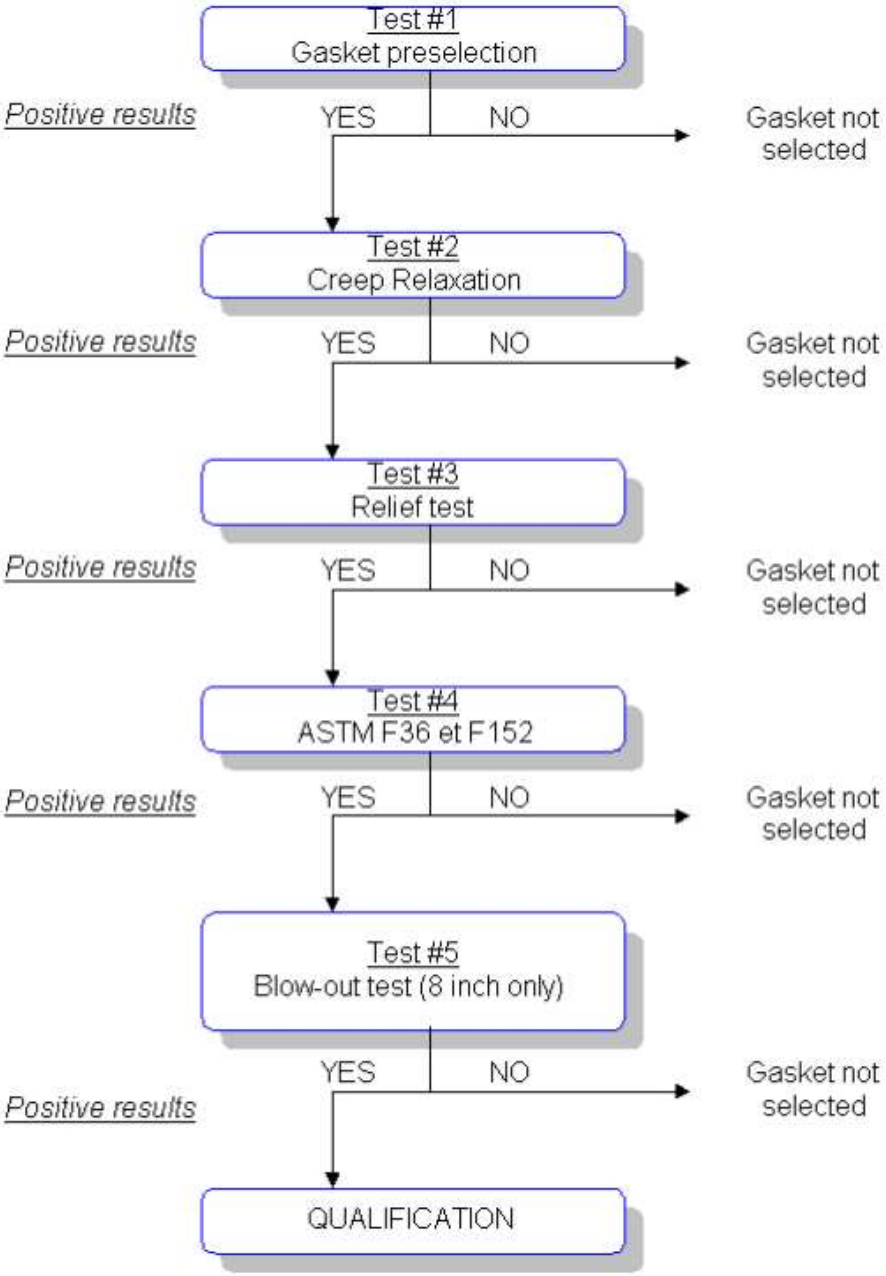
4. Test sequence

All tests are performed three times and sequentially as shown on the diagram below, first with the 8'' gaskets, then with the 16'' gaskets. The blow-out test, test # 5, relates to the 8'' gaskets only. Flange and platen facing shall be checked with appropriate device and the profile characteristics shall be reported at the beginning and at the end of the test sequence.



5. Test # 1: Gasket pre-selection

5.1 Purpose of the tests

This test aims to quickly determine whether the gaskets can suit requirements of the COMPANY

5.2 Testing equipment

The apparatus shall permit the test of the three gaskets of the same material simultaneously and can allow for two materials to be tested together, i.e. six gaskets at the same time. The gaskets are inserted between steel plates with surface condition as defined in paragraph 3 of this appendix.

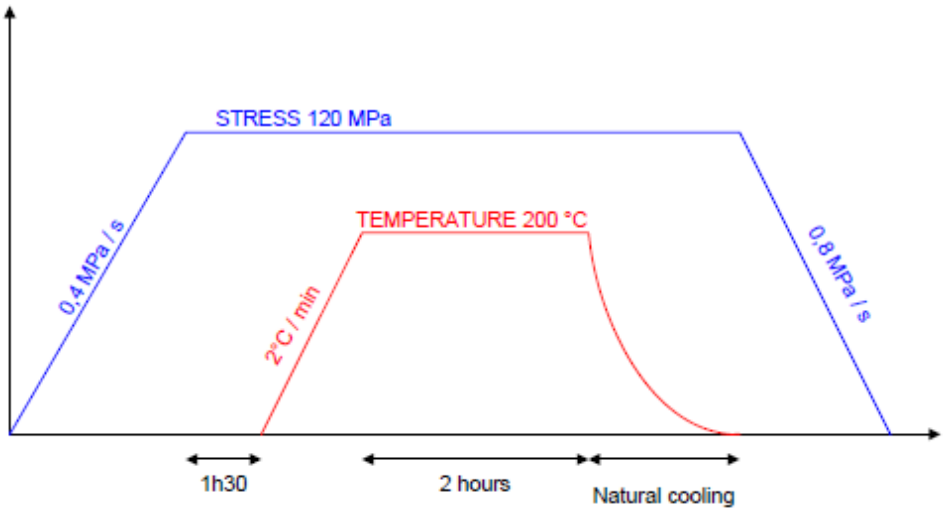
5.3 Stress applied

The gaskets are tightened at a stress of 120 MPa. The stress corresponds to a load of 4360 kN for 8" gaskets and 4980 kN for 16" gaskets.

5.4 Test procedure

As shown on the diagram the procedure consists of:

- Application of a stress of 120 MPa on the assembly
- Stabilization of the stress during one hour and a half
- Then start heating at a rate of 2°C/min up to 200°C
- Holding the temperature during two hours
- Cooling down in calm air
- Then release the stress exerted on the gasket down to 0 MPa.



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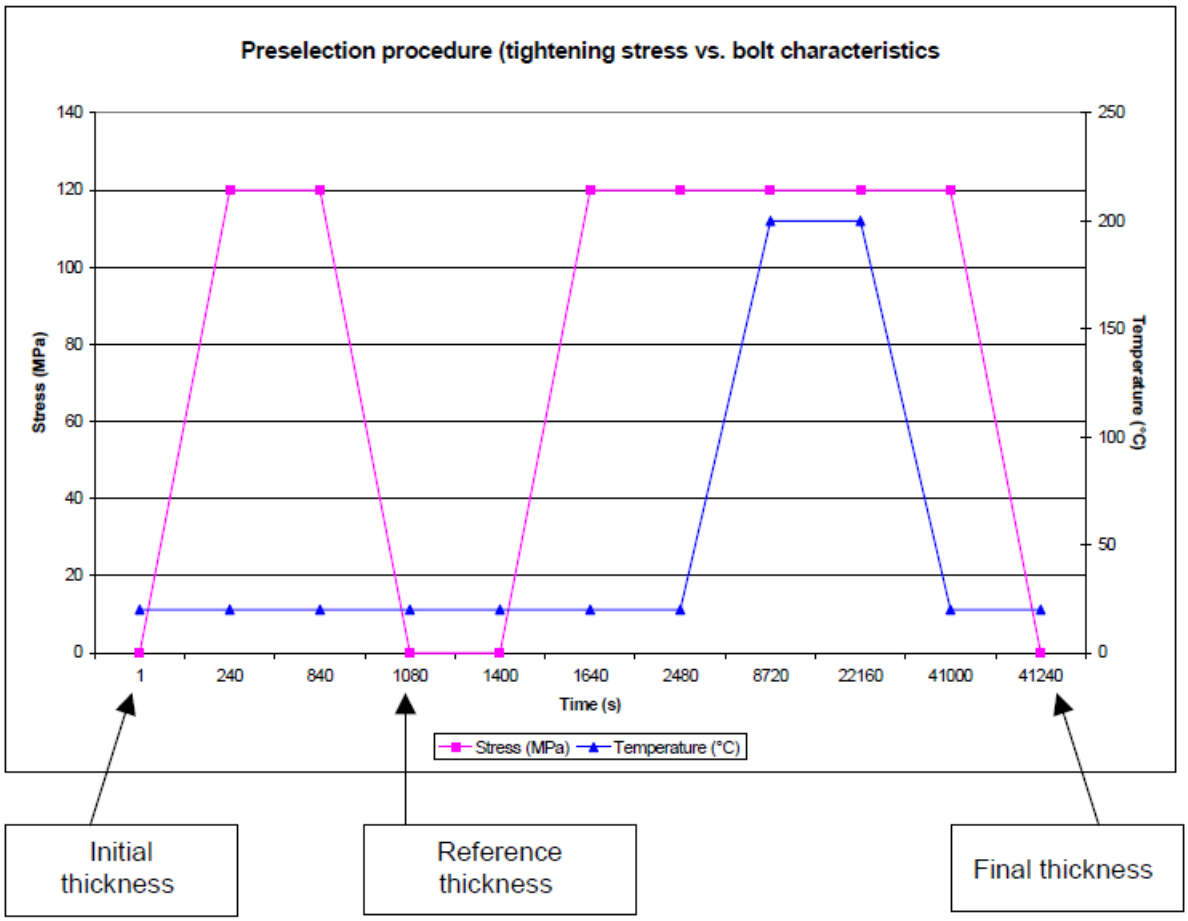
5.5 Measurements

The following measurements shall be made and reported:

- Gasket thickness before testing, after application of a pre-stress load, and after testing
- Inside and outside diameter before and after testing.

5.6 Test results



Variation of wall thickness noted Δe/e and variation of the surface noted Δs/s of the gasket are calculated after testing.

- Δe/e = [Reference thickness - Final thickness] / [Reference thickness] *100%.
- Δs/s = [Final surface - Initial surface) / [Initial surface] * 100%.

The gasket-to-flange adhesion is recorded: Mark 1 corresponds to “non-sticking situation”, mark 3 to “full adherence”, mark 2 for intermediate situation.

The aspect of the gasket is recorded similarly: Mark 1 for “non damaged gasket”, mark 3 for “highly damaged gasket”, mark 2 for intermediate situation.

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5.7 Selection criteria

The average value of Δe/e must be lower than 20% and the average value of Δs/s lower than 25%.

Also the marks for adhesion and the aspect shall be equal to 1. However a mark 2 can be considered on a case by case basis.

Test results (adherence and aspect of gasket)			Passed (Y/N)
Test 1	Test 2	Test 3	
1	1	1	Y
1	1	2	Y
1	2	2	N

Note: Evaluation of marks for gasket adhesion and gasket aspect is compared to a collection of 27 various gaskets already in record obtained in the same testing conditions.

6. Test # 2: Mechanical test to DIN 52913 (Creeping - Stress relief)

6.1 Purpose of the test

The purpose of this test is to verify the mechanical properties of the material and to complete the information available from the other specified tests.

6.2 Testing equipment

The testing equipment consists of two flat, polished compression platens. They are heated and thermally insulated on the outside.

6.3 Test procedure

- Insert the gaskets (powdered with talc or graphite-coated).
- Apply a pressure of 50 MPa
- After 4 minutes, compensate for the pressure drop by re-tightening the joint
- Make the temperature rise up to 300°C in 1 hour
- Stabilization of the temperature during 16 hours
- Release the pressure
- Stop heating.

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6.4 Measurements

Measurements to be made:

- Gasket thickness before and after testing
- Inside and outside diameter before and after testing
- Value read on the comparator.
- Force applied on the gasket.

6.5 Test results

The tensile stress and the creep strength under compression must be recorded.

6.6 Selection Criteria

The tensile stress of the gasket must be greater than 36 N/mm^2 and the variation in diameter shall be less than 15%.

7. Test # 3: Relief tests during heating

7.1 Purpose of the tests

The relief tests aim to measure the gasket sealing behavior during an increase in temperature and in pressure and during the pressure relief.

7.2 Testing equipment

The gasket is installed between two raised faced rigid platens that are representative of standard flanges using a compression press piloted under load. The surface condition of the faces is “stock finish” as defined in paragraph 3 above.

7.3 Loading

The gasket is tightened under a stress of 80 MPa. The stress corresponds to a load of 1560 kN for 8" gaskets, and of 3317 kN for 16" gaskets.

7.4 Test procedure

- The gasket is compressed at a rate of 0.4 MPa/s up to a stress of 80 MPa.
- 30-minute stabilization under stress
- Put under pressure up to 50 bar under helium in about 5 minutes
- Stabilization of the pressure during two hours
- Increase in temperature up to 200°C at a rate of 2°C/min
- Stabilization of the temperature for two hours
- Relief of the pressure exerted on the gasket at a rate of 0.011 MPa/s until it is no longer tight.

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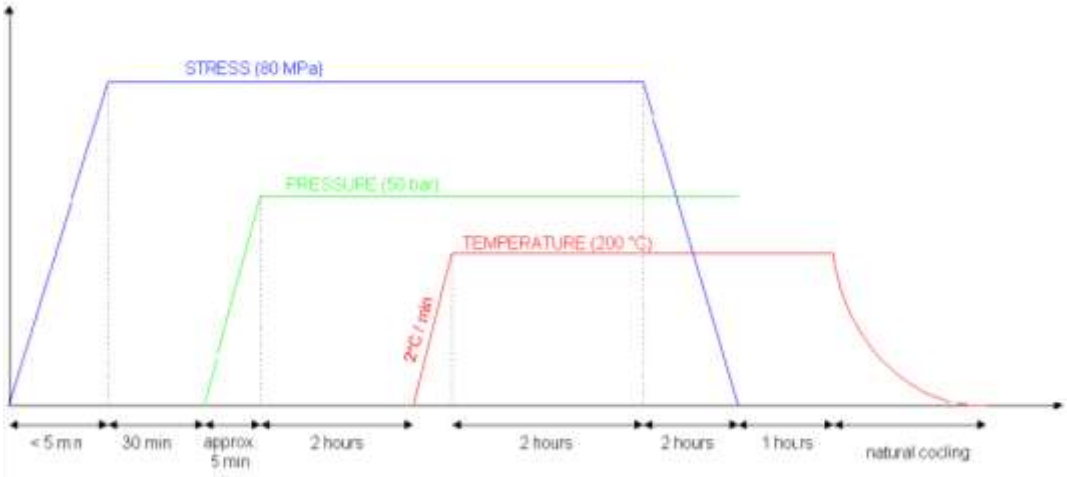
- Natural cooling of the apparatus.



7.5 Measurements

The following parameters are continuously recorded throughout the test:

- Leak
- Stress
- Pressure
- Temperature

7.6 Test results

The main results are:

- The leak variations during testing; graph “leak versus time”
- The leak variations versus the temperature during the two hours stabilization stress/pressure/temperature; graph “leak versus temperature”
- The leak variations versus the stress during the relief of the gasket; graph “leak versus stress applied”.
- Readings of the stress under 5.10^{-3} atm.cm^3/s and of the stress under 10^{-1} atm.cm^3/s (tightness failure), are made and recorded on the “leak vs. stress” curve.
- The tightness criterion (T1 to T5) is also recorded (according to the “Clean Air Act” standard).

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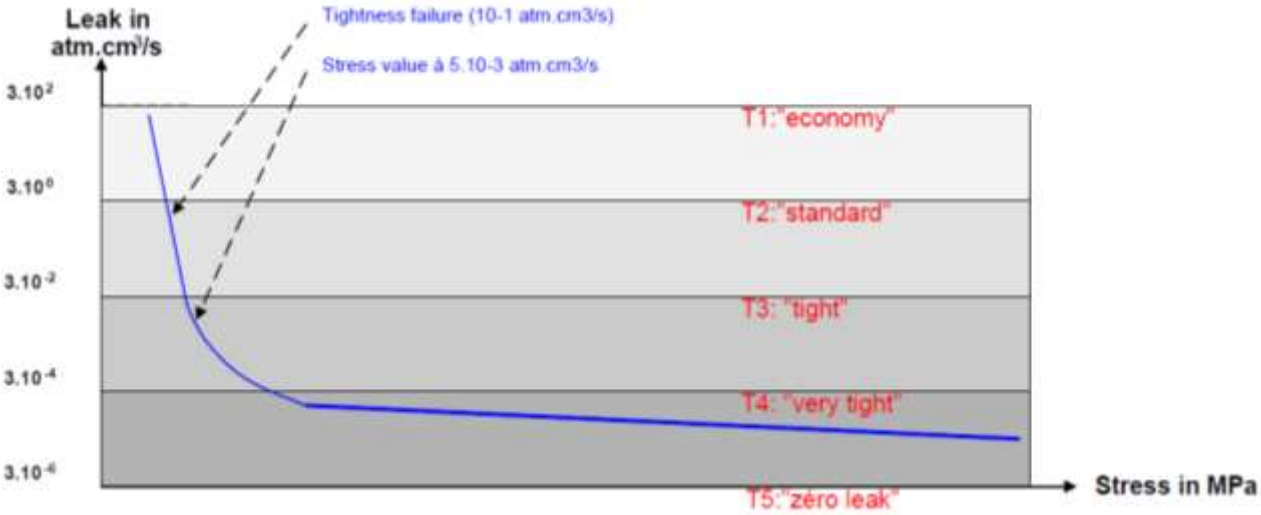


7.7 Selection criteria

Dimensions (inch)	Tightness	A leak = 5.10^{-3} Stress applied on gaskets ≤ (MPa)	Stress applied on the gaskets up to failure ≤ (MPa)
8	T3	15	12
16	½(T2-T3)	25	20

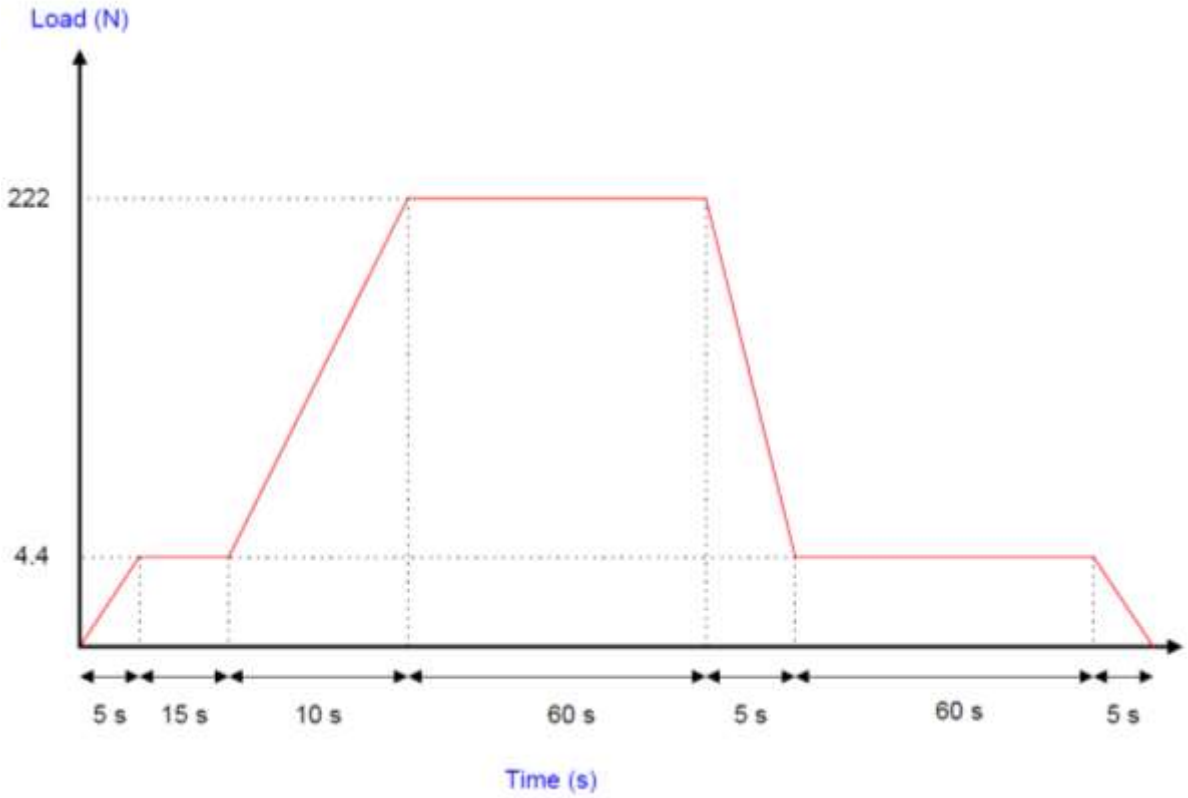
In addition, the leak must be as stable as possible throughout the whole test.

8. Test # 4: Mechanical tests to ASTM F36

8.1 Purpose of the tests

The test is to verify the mechanical properties of the material and to complete the information available from the other specified tests.

8.2 Testing equipment



The tests are made under a computer-controlled compression machine.

A piece of gasket (about 4 cm^2) is compressed at room temperature under a punch of 6.4 mm in diameter.

8.3 Loading

The maximum load applied on the gasket is 222 N. Two plateaus of 4.4 N are made before and after application of the load of 222 N as shown on the graph above.

8.4 Test procedure

Each test is performed three times on 2 mm thick specimens so as to meet the standard criteria.

8.5 Measurements

Continuous measurements to be made:

- Load applied on the gasket
- Gasket thickness.

8.6 Interpretation of the results

Elastic recovery (%) and compressibility (%) of the gasket are evaluated:

- Compressibility: C = [(P-M)/P]*100
- Secondary compressibility: Cs = [(R-M)/R)]*100.

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- Elastic recovery to ASTM F36: E = [(R-M)/(P-M)]*100
- Maximum crushing under load: Em = [(P-R)/P]*100

Where: P is the gasket thickness under the pre-load (4.4 N)

M is the gasket thickness under the full load (222 N)

R is the thickness after testing.

8.7 Selection criteria

The following criteria are considered for the selection of the gasket:

- The compressibility must be greater than 8%
- The elastic recovery must be greater than 55%.

Indices Cs and Em are noted for information only.

9. Test # 4: Mechanical tests to ASTM F152

9.1 Aim of the tests

The test is to verify the mechanical properties of the material and to complete the information available from the other specified tests.

9.2 Testing means

The tests are made under a computer-controlled tension machine. The deformation is measured using an extensometer fastened on the gasket.

9.3 Test procedure

A dumb-bell shaped test piece is placed between two jaws. A tensile force is applied on the test piece until breaking of the gasket. The force cell is class 0.5 – 10 kN type.

9.4 Measurements

Measurements made:

- Force applied on the gasket
- Gasket elongation (mm).

9.5 Interpretation of the results

The breaking load (N) and the breaking stress (MPa) are noted for each test.

A great magnification binocular analysis is made on fiber gaskets in some cases to determine the fiber direction. Two tests are then made:

- In a direction parallel to the fiber length
- In a crosswise direction.

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9.6 Selection criteria

Criteria to be satisfied:

- Graphite gaskets with a metal insert: the breaking load must be greater than 400 N
- Fiber gaskets in the direction of the calendar (either in parallel or crosswise direction): the breaking stress must be greater than 16 MPa.

10. Test # 5: Blow-out tests under standard flanges (8" only)

10.1 Aim of the tests

The tests aim to verify the mechanical and sealing behavior of a gasket becoming loosened while exposed to an internal gas pressure.

10.2 Testing means

The gasket is mounted on a standard flange assembly. Tightening is checked using hydraulic tensioners (8 inch.) together with calibrated deformation gauges mounted on all bolts.

10.3 Loading

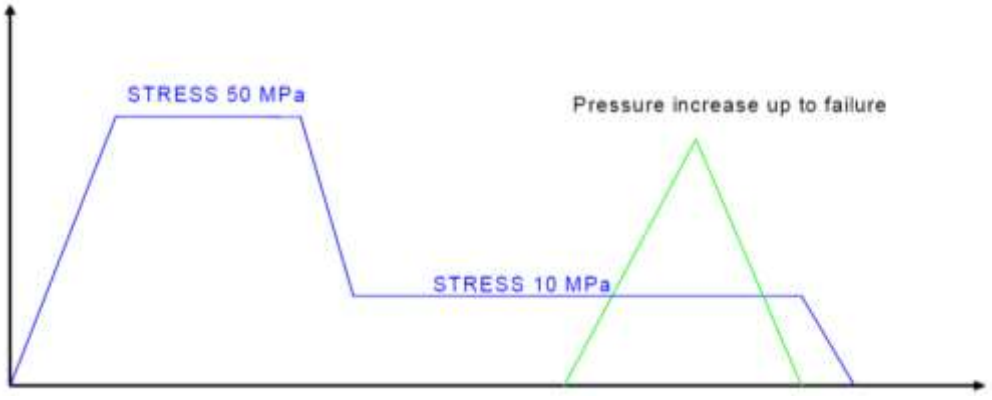
The gasket is first tightened at 50 MPa and then relieved down to 10 MPa, which corresponds to loads of 980 kN and 196 kN respectively.

See graph below.

10.4 Test procedure

The sequence is the following:

- Gasket tightening up to 50 MPa in about 5 minutes.
- Stabilization of the stress for 10 minutes.
- Relief of the pressure exerted on the gasket down to 10 MPa in about 5 minutes.
- Stabilization of the stress for 10 minutes.
- Increase of helium pressure at a rate of 1 bar/s until sealing failure occurs (10^{-1} atm.cm^3/s) or gasket bursts out.
- Relief of the pressure exerted on the gasket down to 0 MPa.



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10.5 Measurements

Leak and internal pressure are continuously recorded throughout the whole test.

10.6 Interpretation of the results

The maximum pressure reached and the tightness failure pressure are measured for each gasket tested (10^{-1} atm.cm^3/s).

After the sealing failure, it is important to check whether the pressure has dropped suddenly or if it is slowly decreasing.

10.7 Selection criteria

Two criteria are considered:

- The gasket does not burst
- The tightness loss shall be better than 55 MPa.

11. Test report

The following documentation shall be submitted by the testing laboratory to the COMPANY for approval. The report shall be made available in hard copy and electronic file, and it shall include:

- The test report, see table 1 attached, signed, dated, and stamped by the testing laboratory in charge.
- The Manufacturer data sheets
- The colour print of the two faces of the three gaskets after test # 1. Each print to show one complete face of the gasket; the size of print shall not be less than 50 mm x 70 mm.
- The three different graphs relating to test # 3 as listed above.
- The colour prints of the 8**"** gaskets after test # 5 is same size of prints as above.
- Chart records of “load versus thickness variation” relating to test **#** 4, ASTM F36, with the three curves on the same graph, and colour prints of the specimen after test ASTM F152.

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Table 1 - Flat Gaskets for Piping- Test Results

Gasket MANUFACTURER: **Gasket actual dimensions:** Internal Diam. 8": Internal Diam. 16":

Production Site: External Diam. 8": External Diam. 16":

Retailer/Supplier: Thickness 8": 2mm ± Thickness 16": 3mm ±

Commercial Reference:

Test		Validation criteria	Results 8"				Results 16"				Mark	Passed (Y/N)
Type	**date**		**Test 1**	**Test 2**	**Test 3**	**Average**	**Test 1**	**Test 2**	**Test 3**	**Average**		
Test#1 Preselection		Δe/e: < 20%	%	%	%	%	%	%	%	%		
		Δs/s < 20%	%	%	%	%	%	%	%	%		
		Adhesion: 1 (2 can be acceptable)										
		Aspect: 1 (2 can be acceptable)										
Test#2 Creep relaxation		Tensile stress: > 36 N/mm^2	τ = N/mm^2	τ = N/mm^2	τ = N/mm^2	τ = N/mm^2	τ = N/mm^2	τ = N/mm^2	τ = N/mm^2	τ = N/mm^2		
Test#3 Relief test		Tightness criterion: < T2 for 8" & < 1/2 (T2-T3) for 16"	Tx	Tx	Tx	Tx	Tx	Tx	Tx	Tx		
		Stress at 5.10^{-3} atm.cm^3/s: < 15 MPa for 8" & < 25 MPa for 16"	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa		
		Stress at tightness failure: < 12 MPa for 8"& < 20 MPa for 16"	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa		
Test #4 to ASTM F36		Compressibility: > 8%	C = %	C = %	C = %	C = %	C = %	C = %	C = %	C = %		
		Elastic recovery: > 55%	E = %	E = %	E = %	E = %	E = %	E = %	E = %	E = %		
Test #4 to ASTM F152		Breaking force: > 400 N (graphite gasket with metal insert)	F = N	F = N	F =	F = N	F = N	F = N	F = N	F = N		
		Breaking stress : > 16 MPa (fiber-based gasket)	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa	τ = MPa		
Test #5 Blow-out-Test (8" only)		The gasket does not blow out	Burst out (Y/N)	Burst out (Y/N)	Burst out (Y/N)	Burst out (Y/N)						

- m and Y verification Yes☐ No☐ Gasket passed ☐
- Testing Laboratory: Date: Signature: Gasket rejected ☐

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Table 2 - Test Criteria

8" Gasket				
Test type	**Measure**	**Criterion mark 1**	**Criterion mark 2**	**Criterion mark 3**
Test # 1 Preselection	Δe/e Δs/s Adhesion	< 20% < 25% 1	between 20% and 30% between 25% and 30% 2	> 30% > 30% 3
Test # 2 Creep relaxation	Stress at traction	> 36MPa	between 30 and 36MPa	< 30MPa
Test # 3 Relief test	Tightness criterion Stress at 5.10^{-3} atm.cm^3/s Stress at tightness failure	>T3 < 15MPa < 12MPa	< T3 >15MPa >12MPa	- - -
Test # 4 to ASTM F36	Compressibility elastic recovery	> 8% > 55%	between 5 and 8% between 40 and 55%	< 5% <40%
Test # 4 to ASTM F152	Breaking stress (graphite) Breaking force (fiber)	> 400N > 16MPa	between 250 and 400N between 10 and 16MPa	<250N <10MPa
Test # 5 Blow out Test	The gasket does not burst out	-	-	-
16" Gasket				
Test type	**Measure**	**Criterion mark 1**	**Criterion mark 2**	**Criterion mark 3**
Test # 1 Preselection	Δe/e Δs/s Adhesion	< 20% < 25% 1	between 20% and 30% between 25% and 30% 2	> 30% > 30% 3
Test # 2 Creep relaxation	Stress at traction	> 36MPa	between 30 and 36MPa	< 30MPa
Test # 3 Relief test	Tightness criterion Stress at 5.10^{-3} atm.cm^3/s Stress at tightness failure	> ½ (T2-T3) < 25MPa < 20MPa	< ½ (T2-T3) > 25MPa > 20MPa	- - -
Test # 4 to ASTM F36	Compressibility elastic recovery	> 8% > 55%	between 5 and 8% between 40 and 55%	< 5% < 40%
Test # 4 to ASTM F152	Breaking stress (graphite) Breaking force (fiber)	> 400N > 16MPa	between 250 and 400N between 10 and 16MPa	< 250N < 10MPa

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