WellProtek™ NBR 163

7-1/16” 5K SBOP

Annular Packing Element

API-16A Design Validation

Customer Data Package

For more information regarding our WellProtek™ Annular Packing Elements please contact:

Freudenberg Oil & Gas Technologies

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WellProtek™ NBR 163 7-1/16” 5K SBOP Annular Packing Elements

API-16A Design Validation

Summary

Freudenberg Oil & Gas Technologies (FO&GT) performed design validation testing in accordance with “Specification for Drill-through Equipment”, API 16A 4th Ed. Sect. 4.5. The required tests of the operational characteristics of the annular packer unit were performed according to section 4.7.2.4 Annular Packing Units Qualification Tests, Table 27—Required Tests and Performance Criteria for Annular Packers to meet performance requirement level PR1.

Design validation testing was performed on OEM or CEM pressure control equipment specified in accordance to the relevant API specification and OEM requirements.

Copies of the reports are included at the end of this document; the original certificates are located at our Petroleum Elastomers (PE) facility in Houston, TX as a part of their quality program.

WellProtek™ NBR 163 7-1/16” 5K SBOP Annular Packing Elements are manufactured in FO&GT’s Fallbrook facility in Houston, Texas. Every element is factory acceptance tested (FAT) before shipment and will be stamped with the official API Monogram®. A FO&GT certificate will be sent with each WellProtek™ Annular Packing Element, certifying that it meets FO&GT quality standards and has been manufactured in compliance with API-Q1 and API-16A requirements.

Testing Requirements

All tests except for temperature testing were conducted using water at an ambient temperature as the wellbore fluid. The system hydraulic pressure was 1,500 psi as recommended by the BOP manufacturer. Table 1 shows all the tests that are required to be in compliance with API-16A design validation.[a]

Tests Completed for FO&GT WellProtek, NBR 163, 7-1/16" 5K SBOP Annular Packing Element

Test	PR1 Section	PR2 Section	PR1 Minimum Performance Criteria	PR2 Minimum Performance Criteria
Sealing Characteristics	4.7.3.18		Reportable	
Fatigue	4.7.3.21		Reportable	
Stripping	4.7.3.24		Reportable	
Low Temperature	4.7.3.26		3 pressure cycles	
Extreme High Temperature	4.7.3.29		1 hour hold time	

Table 1

[a] Table 1 is excerpted from API 16A 4th Ed. Table 27 and modified to reflect the testing completed to validate the annular packing element to meet performance requirement level PR1.

PR1 Sealing Characteristics Test

This test consists of two separate tests as follows:

Constant Wellbore Pressure Test

This test determines the operator closing pressure required to maintain a wellbore pressure seal on a 3.5" test mandrel as a function of wellbore pressures up to full rated working pressure of the blowout preventer.

Constant Closing Pressure Test

This test determines the maximum wellbore pressure obtainable, up to the rated working pressure, for a given closing pressure when closing on a 3.5" test mandrel.

PR1 Fatigue Test

This test determines the ability of an annular packing unit to maintain a low-pressure seal (200 psi to 300 psi), and a rated working pressure (5,000 psi) seal throughout repeated closings and openings.
This test simulates closing and opening the blowout preventer once per day and wellbore pressure testing at full rated working pressure once per week comparable to one year of service.

PR1 Stripping Life Test

This test determines the ability of the annular packing unit to maintain control of wellbore pressure while stripping drill pipe and tool joints through the closed packing unit without exceeding a leak rate of 4 liters/min (1 gal/min).

PR1 Low Temperature Test

This test determines the ability of the annular packing unit used as a pressure-controlling part to maintain a wellbore pressure seal after repeated closings and openings at the minimum rated temperature and rated working pressure of the annular packing unit.

PR1 Extreme High-Temperature Test

This test determines the ability of the annular packing unit used as a pressure-controlling part to maintain a wellbore pressure seal at the extreme rated temperature and rated working pressure of the annular packing unit.

Acceptance Criteria

Except for the stripping test, the acceptance criterion for all tests that verify pressure integrity is zero visible leakage, as established by FO&GT standards.

Technical Data Sheet

This technical data sheet meets the requirements set forth in API 16A 4th Ed., April 2017, Section 4.10.

Product	7-1/16" – 5,000 PSI SBOP Packing Unit
Part Number	10044893-33
Performance Requirement (PR) Level	PR1
Bore Size	7-1/16"
Rated Working Pressure	5,000 PSI
Temperature Rating	EGA
Elastomer Type	Nitrile (NBR)
Qualification Test Results	
• Sealing Characteristics	See Tables 1 & 2
• Full Closure Pressure Test, Open Hole *Complete Shut-off (CSO)*	2,500 PSI maximum rated working pressure at CSO
• Fatigue	55 cycles @ 1,500 PSI closing pressure
• Stripping	1,200 ft
• Low Temperature	• 1,450 PSI closing pressure @ low wellbore pressure & 30°F • 1,500 PSI closing pressure @ high wellbore pressure & 30°F
• Extreme High Temperature	1,500 PSI closing pressure @ 180°F
Size	18.80" O.D. x 8.45" Height
Weight	120 lb

Table 1 - Constant Wellbore Pressure Test[b]

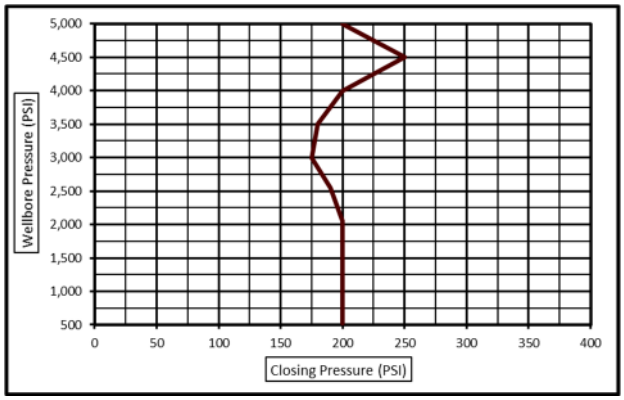
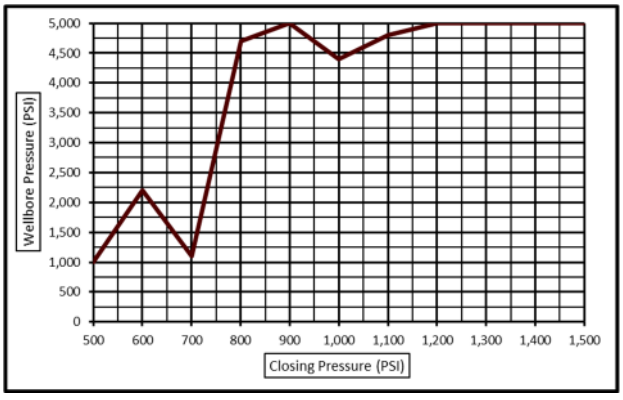


Table 2 - Constant Closing Pressure Test[b]



[b] Wellbore pressure seal developed on a 3.5" drill pipe

Material Data Sheet

NBR 163*

Physical properties	Typical Values
Hardness	
ASTM D 2240, Shore A, Max Readout	79.0 Shore
Tensile strength	
ISO 37 / ASTM D 412, S2	4074 Psi 28.1 MPa
Modulus	
ISO 37 / ASTM D 412, S2	
50% Modulus	350 Psi 2.4 MPa
100% Modulus	627 Psi 4.3 MPa
200% Modulus	1611 Psi 11.1 MPa
300% Modulus	2591 Psi 17.9 MPa
Elongation at break	
ISO 37 / ASTM D 412, S2	543.0 %
Tear strength	
ISO 34-1 figure 2 / ASTM D 624-C	251 pound/inch
Compression set	
ISO 815-B / ASTM D 395 -1	
22h at 100 ^{0}C (212^{0}F)	34 %
Change after aging in IRM 903: 70h at 100^{0}C (212^{0}F), ASTM D 471	
ASTM D 2240, Shore A, Max Readout	-4
Tensile strength (ISO 37 / ASTM D 412, S2)	-38 %
Elongation at break (ISO 37 / ASTM D 412, S2)	-60 %
Volume change (ISO 1817)	6 %
Change after aging in IRM 901: 70h at 121.1ºC (250ºF), ASTM D 471	
ASTM D 2240, Shore A, 1s	7
Tensile strength (ISO 37 / ASTM D412, Type C)	-4 %
Elongation at break (ISO 37 / ASTM D412, Type C)	-45 %
Volume change (ASTM D297)	-6 %

Listed values are nominal values based on testing performed by FO&GT in accordance with industry testing standards. Actual values may vary.
*The NBR 163 compound was identified as LAB 2012 006-8 and during the API-16A design validation tests was documented as FOG 006-8.

Temperature Ratings

The Freudenberg FO&GT WellProtek, NBR 163, 7-1/16" 5K SBOP Annular Packing Element has been temperature tested per API 16A and meets the requirements for temperature classification per Table 4 in API 16A 4th Ed. at a performance requirement level 1 (PR1).

Table 4 - Temperature Ratings for Non-Metallic Sealing Materials

Low Temperature Limit (first digit)			Continuous Elevated Temperature Limit[a] (second digit)			Extreme Temperature Limit (third digit)		
Code	Temperature		Code	Temperature		Code	Temperature	
	°C	°F		°C	°F		°C	°F
A	-26	-15	A	66	150	A	82	180
B	-18	0	B	82	180	B	93	200
C	-12	10	C	99	210	C	104	220
D	-7	20	D	116	240	D	121	250
E	-1	30	E	132	270	E	149	300
F	4	40	F	149	300	F	177	350
G	Other	Other	G	Other	Other	G	Other	Other

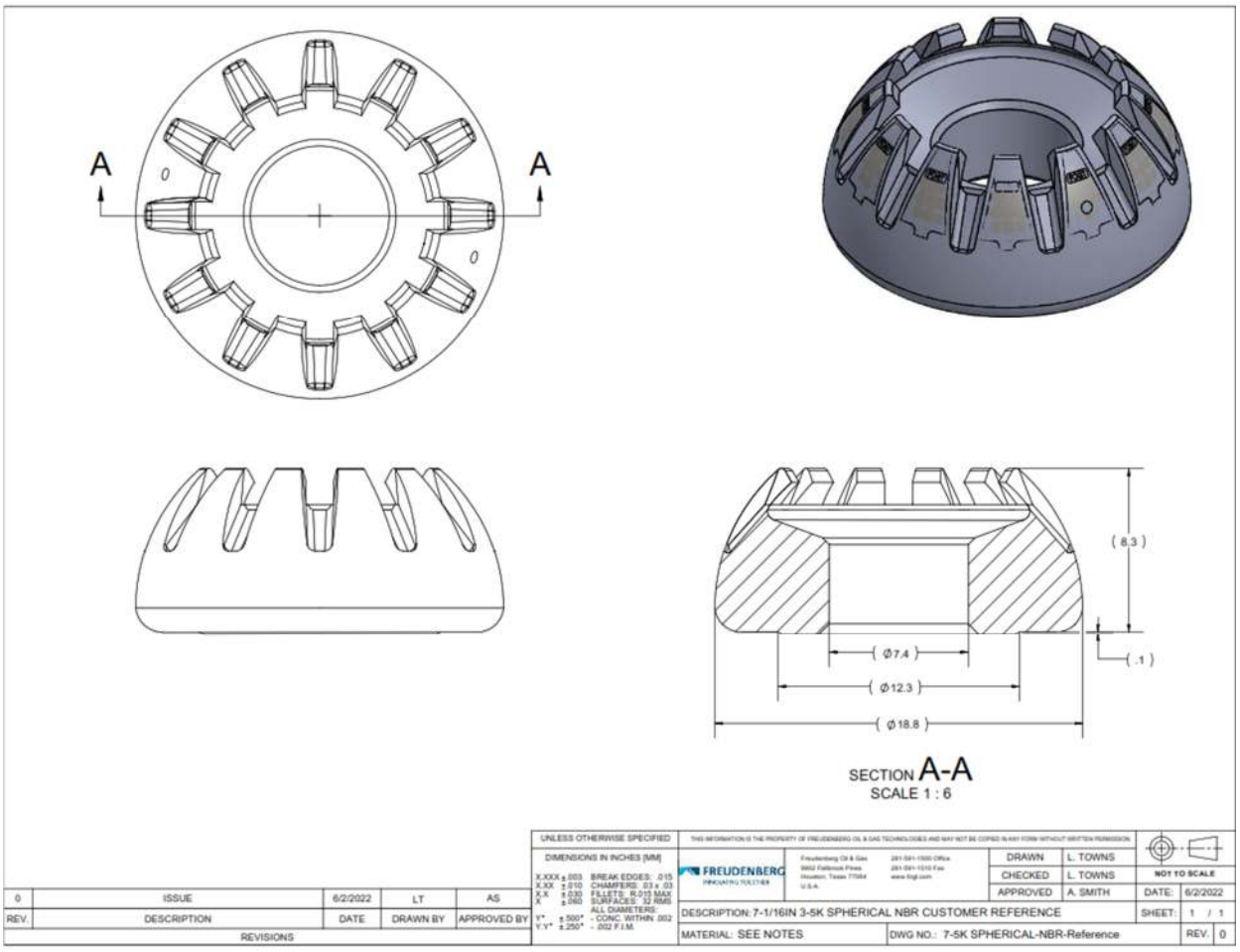
[a] not required for PR1
EXAMPLE Material "FDE" has a low temperature rating of 40 °F, a continuous elevated temperature rating of 240 °F, and an extreme temperature limit of 300 °F.

Per API 16A marking requirements, a middle code letter "G" is used for products temperature tested to PR1.

Product Description

FO&GT Part #	Element Type	Element Description			Element Style
		Element size	Rated Working Pressure	Type	
10044893-33	WellProtek™ NBR 163	7-1/16”	5,000 psi	Spherical	Shaffer Style

Dimensional Details



Elastomer Storage Guideline for FO&GT Pressure Control Products

The following guideline describes how ram blow-out preventer (BOP) packers, annular BOP packing elements, and all other related BOP elastomeric seals should be properly stored to achieve the stated shelf life for each elastomer type as noted in Table 2.

Most polymeric items, including vulcanized rubber and other elastomers, tend to change their properties during storage. Without the proper handling, parts could become defective due to hardening, softening, cracking, crating or other degradation as the result of oxygen, ozone, light, heat and/or humidity.

The aging process is predominantly dependent on the following factors:

- Temperature
- Humidity
- Light
- Oxygen and Ozone
- Deformation

As such, the following storage recommendations are suggested to better preserve both elastomer properties and composite items:

Temperature

Storage temperatures should not exceed 75ºF. Low temperatures are not directly correlated to permanent damage if elastomeric items are carefully handled and not distorted. When items are taken out of low temperature storage of 60°F or less, then they should be warmed up to approximately 85°F prior to installation.

Humidity

Optimum humidity should be approximately 65% in a draft-free atmosphere.

Light

It is highly important to protect elastomeric items from direct sunlight and/or strong artificial light with a high ultraviolet content. Unless items are packed in opaque containers, it is advisable to cover storage windows with red or orange screens or coatings.

Oxygen and Ozone

Elastomeric items should be protected from circulating air while in storage by remaining wrapped or bagged. Items should be stored in rooms apart from equipment that creates electric sparks or discharges as the ozone released is particularly harmful to rubber.

Deformation

Where possible, rubber items should be stored in a relaxed position, free from tension or compression. Laying the item flat, avoiding suspension or crushing, will keep it free from strain and will minimize deformation.

Stock Rotation

Elastomers should be stored for as short a period as possible, and strict stock rotation should be followed.

Cleaning

Organic solvents such as trichloroethylene, carbon tetrachloride and petroleum are the most harmful agents and should be avoided. Soap and water and methylated spirits are the least harmful. All parts should be dried at room temperature before use.

Shelf Life

The table below shows the storage life of seal components made from common elastomer materials stored under the conditions covered by these guidelines. Improper storage will reduce the shelf life.

If the shelf life or expiration dates marked on the part or packaging is different than the period listed in Table 2, the part or packaging dates shall be followed.

Elastomer	Maximum Storage Period (years)
Nitrile (NBR)	7

Table 2

Test Certificates

The following API-16A tests, as defined in its 4th edition, for performing PR1 testing of annular BOP components were 3rd party witnessed or verified as part of the FO&GT design validation process[c]. All tests meet or exceed API-16A standards. The list of tests performed, and their corresponding certificates are as follows:

WellProtek™ NBR 163[d] 7-1/16" 5K Annular Packing Elements – API-16A 4th Edition, PR1

Test[e]	Report ID
Sealing Characteristics Test	DNV Report ID 2014-01-20-B
Fatigue Test	DNV Report ID 2014-01-17-A
Stripping Test	FO&GT Lab Report ID C-00109
High Temperature Test	DNV Report ID 2015-05-20-A
Low Temperature Test	DNV Report ID 2015-03-16-A

[c] The design validation tests performed in accordance with API 16A 3rd Edition and their respective requirements are equivalent to the validation tests and requirements outlined in API 16A 4th Edition to meet performance requirement level 1 (PR1) for the annular packing element.

[d] The NBR 163 compound was identified as LAB 2012 006-8 and during the API-16A design validation tests was documented as FOG 006-8.

[e] Sealing Characteristics Test, Fatigue Test, High Temperature Test, & Low Temperature Test were 3rd party witnessed. The Stripping Test was not 3rd party witnessed.

[f] The High Temperature Test & Low Temperature Tests list the annular packing element part number as 10019338-33. This is the base part number for manufacturing the WellProtekTM NBR 163 7-1/16" 5K SBOP Annular Packing Elements labelled as part number 10044893-33. 10019338-33 is equivalent in design and materials to 10044893-33 but has not been Factory Acceptance Tested.

Sealing Characteristics Test

Station I.D.:	TAMUS467
Project No.:	PP096011
Surveyor I.D.:	MMATI
Report I.D.:	2014-01-20-B

DET NORSKE VERITAS

SURVEY REPORT

P.O. Number:	10419	**Date:**	20 Jan 2014
Main Vendor:	Freudenberg Oil & Gas	**Location:**	Houston ,TX
End User:	N/A	**Vendor Contact:**	Juan Galan
Vendor Ref:	N/A	**Vendor Phone:**	281-233-1410
WO No:	2013-329	**Quantity:**	1
Receiving No:	R2013-0548	**Receiving No.:**	NBR 006-8#2

Equipment Description

Sealing characteristics test on 7 1/16 – 5K Spherical BOP NBR FOG 006-8

Purpose of Survey: Reviewed Sealing characteristics Test on 7 1/16 – 5K Spherical BOP NBR FOG 006-8

Acceptance Criteria:
- API 16A "Specification for Drill-through Equipment" 3rd Ed.

Reference Documents:
- Freundenberg Procedure No: BOP 11-6-13
- API 16A "Specification for Drill-through Equipment" 3rd Ed

Digitally Signed By: Matinfar, Mehdi
Location: DNV Houston, USA
Signing Date: 5/9/2014

Surveyor / date: Mehdi Matinfar / 2014-01-20

Distribution:		**Attn:**	**E-Mail Address:**
Original to Client:	Freudenberg Oil & Gas	Juan Galan	Juan.Galan@fogt.com
Copy to:	NA		
Copy to File:	PP096011		

Fatigue Test

Station I.D.:	TAMUS467
Project No.:	PP096011
Surveyor I.D.:	MMATI
Report I.D.:	2014-01-17-A

DNV

DET NORSKE VERITAS

SURVEY REPORT

P.O. Number:	10419	**Date:**	17 Jan 2014
Main Vendor:	Freudenberg Oil & Gas	**Location:**	Houston ,TX
End User:	N/A	**Vendor Contact:**	Juan Galan
Vendor Ref:	N/A	**Vendor Phone:**	281-233-1410
WO No:	2013-328	**Quantity:**	1
Receiving No:	R2013-0547	**Recieving No.:**	NBR 006-8#3

Equipment Description

Fatigue test on 7 1/16 – 5K Spherical BOP NBR FOG 006-8

Purpose of Survey: Witnessing Fatigue test on 7 1/16 – 5K Spherical BOP NBR FOG 006-8 for Design Validation Testing of annular packer unit

Acceptance Criteria:
- API 16A "Specification for Drill-through Equipment" 3rd Ed.

Reference Documents:
- Freundenberg Procedure No: BOP 11-6-13
- API 16A "Specification for Drill-through Equipment" 3rd Ed

Digitally Signed By: Matinfar, Mehdi
Location: DNV Houston, USA
Signing Date: 5/9/2014

Surveyor / date: Mehdi Matinfar / 2014-01-17

Distribution:		**Attn:**	**E-Mail Address:**
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Stripping Test

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Certificate of Test

Freudenberg Oil & Gas Technologies' 7-1/16" x 5,000 psi NBR 163 annular packing unit was successfully stripped 1200 ft for design validation in accordance with API 16A, Fourth Edition, section 4.7.3.25 PR2 procedures and acceptance criterion.

Product Details: FOGT 7 1/16" x 5,000 psi Annular Packing Unit NBR 163

Manufacturer:	Freudenberg Oil & Gas Technologies
Part Number:	10019338-33
Batch Number:	3786
Compound Description:	NBR 163

Test Parameters

Validation Test Standard:	API 16A Fourth Edition PR2, Stripping Test			
BOP Type:	Annular, 7-1/16" x 5,000 psi			
BOP Model:	BOP Products Series 800			
BOP Serial Number:	B963-14			
Wellbore Pressure, minimum:	62	bar	900	psi
Wellbore Pressure, maximum:	75	bar	1090	psi
Closing Pressure, minimum:	61	bar	889	psi
Closing Pressure, maximum:	81	bar	1181	psi
Temperature, minimum:	78 °F			
Temperature, maximum:	86 °F			
Distance:	1200 ft			
Number of cycles:	115			
Test Medium:	Water			
FOGT Work Order:	2021 081			

Test Details

Test Performed by	Freudenberg Oil & Gas Technologies
Test Location	Fallbrook Stripping Unit 9902 Fallbrook Pines, Suites 100 Houston Texas 77064
Internal Test Procedures	SOP-00135/1, in accordance with API 16A Fourth Edition, PR2
Test Completion Date	June 15, 2021
Test Results	Not exceeding a leak rate of 1 gal/minute

Authorized by:

James Smith

Lab Manager, Materials Development and Product Test Laboratory

C-00109/2

High Temperature Test

DNV·GL

Station I.D.:	MEAUS467
Project No.:	A0076195
Surveyor I.D.:	MATI
Report I.D.:	2015-05-20-A

SURVEY REPORT

P.O. Number:	20386	**Date:**	2015-05-20
Main Vendor:	Freudenberg Oil & Gas	**Location:**	Houston, Tx
Sub Vendor:	NA	**Vendor Contact:**	Gordon Koeck
Vendor Ref:	WO# FOG 2015-0154	**Vendor Phone:**	281-233-1447
Receiving. No:	R2015-0166	**Quantity:**	1
Element / ID:	10019338-33	**Serial No.:**	51689

Equipment Description

High temperature test on 7 1/16" – 5K Annular Spherical BOP-NBR163

Purpose of Survey: 3rd Party Witness of High temperature test on 7 1/16" – 5K Annular Spherical BOP NBR163

Acceptance Criteria:
- API 16A "Specification for Drill-through Equipment" 3rd Ed.

Reference Documents:
- Freudenberg FAT Procedure No: WI-021 Rev. 1
- API 16A "Specification for Drill-through Equipment" 3rd Ed- Annex D3

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Surveyor

Surveyor / date: Mehdi Matinfar / 2015-05-20

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Low Temperature

DNV·GL

Station I.D.:	MEAUS467
Project No.:	A0076195
Surveyor I.D.:	MATI
Report I.D.:	2015-03-16-A

SURVEY REPORT

P.O. Number:	20386	**Date:**	2015-03-16
Main Vendor:	Freudenberg Oil & Gas	**Location:**	Houston, Tx
Sub Vendor:	NA	**Vendor Contact:**	Gordon Koeck
Vendor Ref:	WO# FOG 2015-0064	**Vendor Phone:**	281-233-1447
Receiving. No:	R2015-0089	**Quantity:**	1
Element / ID:	10019338-33	**Serial No.:**	56178-1

Equipment Description

Low temperature test on 7 1/16" – 5K Annular Spherical BOP-NBR163

Purpose of Survey: 3rd Party Witness of Low temperature test on 7 1/16" – 5K Annular Spherical BOP NBR163

Acceptance Criteria:
- API 16A "Specification for Drill-through Equipment" 3rd Ed.

Reference Documents:
- Freudenberg FAT Procedure No: WI-023 Rev. 1
- API 16A "Specification for Drill-through Equipment" 3rd Ed- Annex D5

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Surveyor

Surveyor / date: Mehdi Matinfar / 2015-03-16

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Certificate of Quality

Per API-16A, every WellProtek™ NBR 163 7-1/16” 5K SBOP Annular Packing Element will be shipped with the required documentation including a FO&GT certificate of quality.

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Certificate of Quality

Freudenberg Oil & Gas Technologies (FO&GT) - Petroleum Elastomers (PE) certifies that the WellProtek™ Annular Packing Element listed herein has been manufactured and inspected in accordance with API Q1 and API-16A standards.

FO&GT - PE certifies this WellProtek™ Annular Packing Element has passed the Factory Acceptance Test (FAT) and meets FO&GT design acceptance criteria.

Part Number: .....

Serial Number: .....

Description: .....

Compound: .....

Date Manufactured: .....

Expiration Date: .....

QC CERTIFIED
Site # 33-01

Quality Assurance ..... Quality Inspector ..... Date .....

For service, call: +1 281 591-1500 (M - F from 8 a.m. - 5 p.m.)
After hours, call: +1 713 397-0009

www.fogt.com

Keep this document for reference!

Certificate of Conformance

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CERTIFICATE OF CONFORMANCE

Freudenberg Oil & Gas Technologies-Petroleum Elastomers certify that the product listed herein have been manufactured and inspected in accordance with API 16A and Freudenberg Oil & Gas Technologies specification requirements.

Certificate No.:		**Date:**	
Customer:		**Customer PO Number:**	
FOGT Sales Order:		**Product Specification License No.:**	
Date of Manufacture:		**Serial Number:**	

A. Assurance:

This is to confirm that the drill through "Annular Packing Unit" manufactured per the above purchase order and as listed below have been manufactured, inspected and maintained in accordance with the following:

- API Q1, Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry, Latest edition including all addendums and errata.
- API 16A, Specification for Drill-through Equipment, Latest edition including all addendums and errata.

B. The certification is related to the following testing requirements:

Sealing Characteristics	High Temperature
Fatigue	Low Temperature
Test for Stripping Life	Continuous Operating Temperature
Factory Acceptance Test	

C. Ratings

Rated Working Pressure:	
Non-metallic Temperature Rating:	

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F-00107 Rev.4
Date: 05-18-2020

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CERTIFICATE OF CONFORMANCE

D. List of inspected annular packing unit:

Item#	SAP Part No.	Description	Serial Number	Expiration Date

E. Comments:

- All documentation in support of the above listed products is retained on file by Freudenberg Oil & Gas Technologies – Petroleum Elastomers for a minimum of 10 years from the date of manufacture and can be made available to the purchaser upon request.

F. Freudenberg Oil & Gas Technologies disclaimer

- "These commodities, technology, or software were exported from the United States in accordance with the Export Administration Regulations. Diversion contrary to U.S. law is prohibited."

G. Certificate of Conformance Approval

- All documents and inspection reports to support this certificate of conformance have been verified to the best of my knowledge to be true and correct.

Name:		Signature:	
Title:			
Phone:			
Fax:			
Email:			

Notice: This certificate is subject to terms and conditions as set forth in the original purchase order and contract documents. Any significant change in design or construction may render this Certificate invalid.