WellProtek™ NBR 162

13-5/8” 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

9902 Fallbrook Pines Drive, Suite 100
Houston, Texas 77064 USA

Phone: +1 281-591-1500
(M-F 8 AM – 5 PM Central Time US)
After Hours, call: +1 713-397-0009
Fax: + 1 281-591-1510

WellProtek@fogt.com

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WellProtek™ NBR 162 13-5/8" 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 with OEM or CEM pressure control equipment specified in accordance to the relevant API specification and OEM requirements.

All tests were 3rd party witnessed or verified. 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 162 13-5/8" 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®. FO&GT certificates 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 162, 13-5/8" 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 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 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	13-5/8" – 5,000 PSI SBOP Packing Unit
Part Number	10044895-33
Performance Requirement (PR) Level	PR1
Bore Size	13-5/8"
Rated Working Pressure	5,000 PSI
Temperature Rating	FGD
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	50 cycles @ 1,500 PSI closing pressure 60 cycles total
• Stripping	7,567 ft
• Low Temperature	• 1,500 PSI closing pressure @ low wellbore pressure & 40°F • 1,475 PSI closing pressure @ high wellbore pressure & 40°F
• Extreme High Temperature	1,500 PSI closing pressure @ 275°F
Size	31.69" O.D. x 14.50" Height
Weight	604 lb

Table 1 - Constant Wellbore Pressure Test[b]

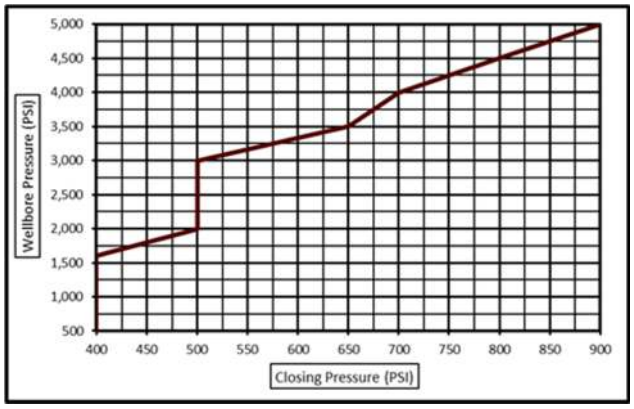
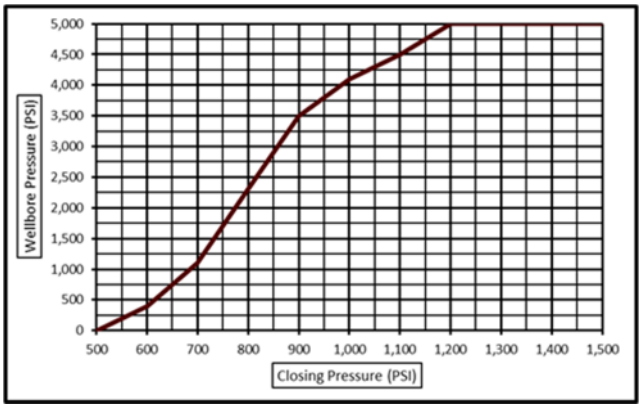


Table 2 - Constant Closing Pressure Test[b]



[b] Wellbore pressure seal developed on a 5" drill pipe

Material Data Sheet

NBR 162*

Physical properties	Typical Values	
Hardness	79.0 Shore	
ASTM D 2240, Shore A, Max Readout		
Tensile strength	3700 Psi	25.5 MPa
ISO 37 / ASTM D 412, S2		
Modulus		
ISO 37 / ASTM D 412, S2		
50% Modulus	370 Psi	2.6 MPa
100% Modulus	620 Psi	4.3 MPa
200% Modulus	1500 Psi	10.3 MPa
300% Modulus	2300 Psi	15.9 MPa
Elongation at break		
ISO 37 / ASTM D 412, S2	520%	
Tear strength		
ISO 34-1 figure 2 / ASTM D 624-C	329 pound/inch	
Compression set		
ISO 815-B / ASTM D 395 -1		
72h at 80 ºC (176ºF)	29%	
24h at 80 ºC (176ºF)	18%	
Change after aging in IRM 903: 70h at 100ºC (212ºF), ASTM D 471		
ASTM D 2240, Shore A, Max Readout	-4	
Tensile strength (ISO 37 / ASTM D 412, S2)	-31%	
Elongation at break (ISO 37 / ASTM D 412, S2)	-52%	
Volume change (ISO 1817)	11%	
Change after aging in IRM 901: 70h at 149ºC (300ºF), ASTM D 471		
ASTM D 2240, Shore A, Max Readout	8	
Tensile strength (ISO 37 / ASTM D 412, S2)	-1.1%	
Elongation at break (ISO 37 / ASTM D 412, S2)	-48.9%	
Volume change (ISO 1817)	-7%	

Listed values are nominal values based on testing performed by FO&GT in accordance with industry testing standards. Actual values may vary.
*The NBR 162 compound was identified as LAB 2012 006-9 and during the API-16A design validation tests was documented as FOG 006-9.

Temperature Ratings

The Freudenberg FO&GT WellProtek, NBR 162, 13-5/8" 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

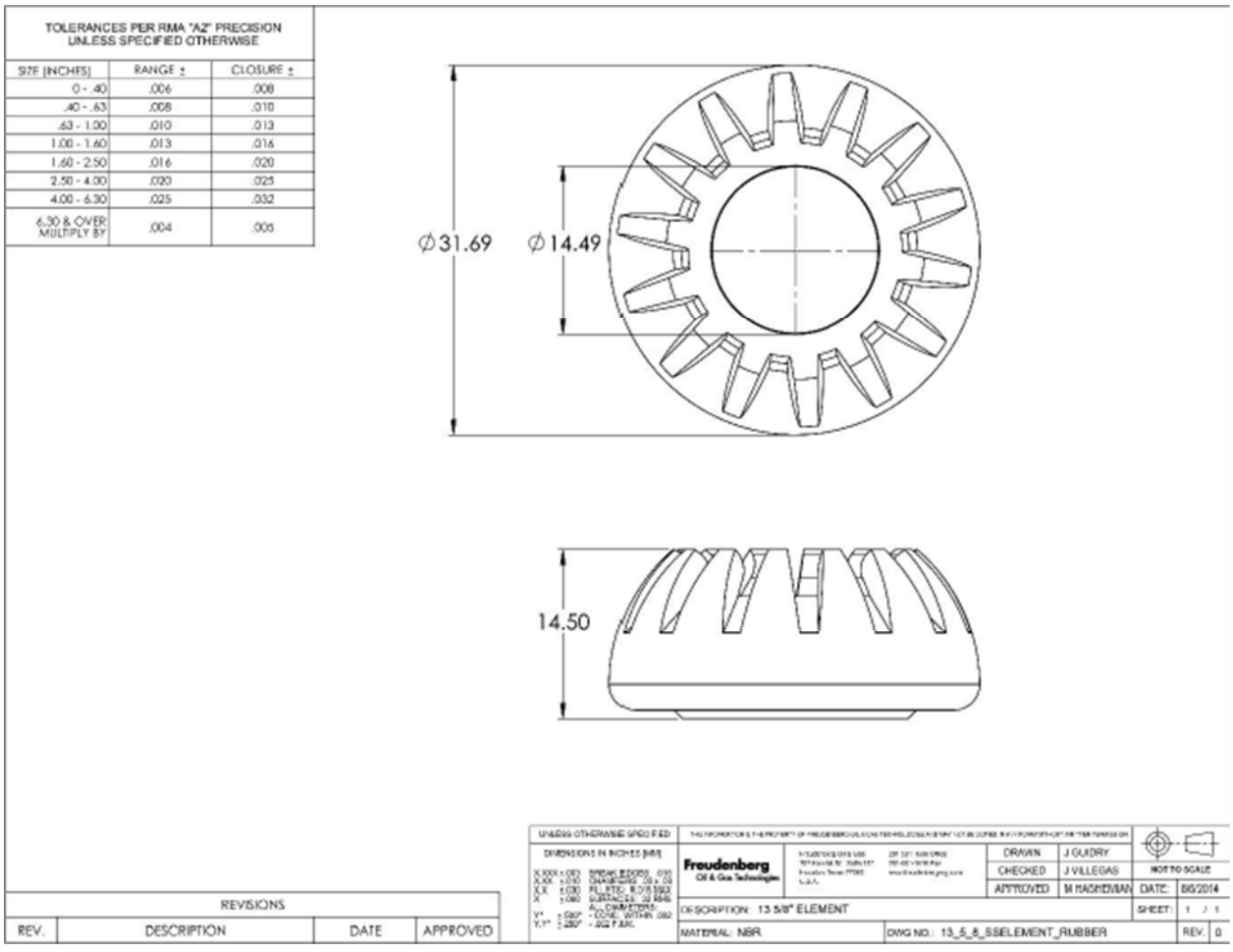
[a] not required for PR1
EXAMPLE Material "FDE" has a low temperature rating of 40 °F, a continuous elevated temperature rating of 240 °F, and an extreme temperature limit of 300 °F.

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	
10044895-33	WellProtek™ NBR 162	13 5/8"	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 162[d] 13-5/8" 5K Annular Packing Elements – API-16A 4th Edition, PR1

Test	Report ID
Sealing Characteristics Test	DNV Report ID 2013-09-20-A
Fatigue Test	DNV Report ID 2013-09-27-A
Stripping Test	Tejas Report ID 1202014-2
High Temperature Test	FO&GT Lab Report ID C-00014
Low Temperature Test	DNV Report ID 2014-04-16-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 162 compound was identified as LAB 2012 006-9 and during the API-16A design validation tests was documented as FOG 006-9.

Sealing Characteristics Test

Station I.D.:	TAMUS467
Project No.:	PP072883
Surveyor I.D.:	MMATI
Report I.D.:	2013-09-20-A

DET NORSKE VERITAS

SURVEY REPORT

P.O. Number:	LAB1236	**Date:**	20 SEP 2013
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:	2013-300	**Quantity:**	1
Part No:	R2013-0527	**Serial No.:**	F100003

Equipment Description

Sealing Characteristics Test 13 5/8" -5K Spherical BOP
NBR FOG 006-9

Purpose of Survey: Witnessing Sealing Characteristics test on 13 5/8" – 5K Spherical BOP NBR FOG 006-9 for Design Validation Testing of annular packer unit

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

Reference Documents:
- API 16A "Specification for Drill-through Equipment" 3rd Ed.
- Freundenberg Procedure No: BOP 8-14-13

Digitally Signed By: Koehne, Craig A.
Location: DNV Houston, USA
Signing Date: 2013-09-30

Surveyor / date: Mehdi Matinfar / 2013-09-20

Distribution:		**Attn:**	**E-Mail Address:**
Original to Client:	Freudenberg Oil & Gas	Juan Galan	Juan.Galan@fogt.com
Copy to:	NA		
Copy to File:	PP072883		

Fatigue Test

Station I.D.:	TAMUS467
Project No.:	PP072883
Surveyor I.D.:	MMATI
Report I.D.:	2013-09-27-A

DET NORSKE VERITAS

SURVEY REPORT

P.O. Number:	LAB1236	**Date:**	27 SEP 2013
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:	2013-301	**Quantity:**	1
Part No:	R2013-0528	**Serial No.:**	F100003

Equipment Description

Fatigue Test Test 13 5/8" Spherical BOP
NBR FOG 006-9

Purpose of Survey: Witnessing Fatigue test on 13 5/8 – 5K Spherical BOP NBR FOG 006-9 for Design Validation Testing of annular packer unit

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

Reference Documents:
- API 16A "Specification for Drill-through Equipment" 3rd Ed.
- Freundenberg Procedure No: BOP 9-17-13

Digitally Signed By: Koehne, Craig A.
Location: DNV Houston, USA
Signing Date: 2013-09-30

Surveyor / date: Mehdi Matinfar / 2013-09-27

Distribution:		**Attn:**	**E-Mail Address:**
Original to Client:	Freudenberg Oil & Gas	Juan Galan	Juan.Galan@fogt.com
Copy to:	NA		
Copy to File:	PP072883		

Stripping Test

Tejas

Testing Project Documentation Number : 10004
Tejas Documentation Number: 1202014-2

Test Summary Number: 10004 1202014-2

Test Summary Report

IDENTIFICATION			
1. Originator Name:	Ben East	5. Date:	1/20/2014
2. Customer:	Freudenberg Oil & Gas	6. Number:	10004 1202014-2
3. Part Description:	13" 5K Annular BOP Element	7. Quantity:	1
4. Part ID:	FOG WO2013379 R2013-0588	8. DWG Number:	n/a

9. Objectives Completed:

- ☑ RECEIVING
- ☑ SHIPPING
- ☑ SETUP
- ☑ RIG DOWN
- ☑ TESTING
- ☐ OTHER:

10. Description of Test Required

Program steps 1-8 of Freudenberg Test Procedure WI-022 were completed by Tejas. The test consisted of stripping a test mandrel with a simulated tool joint through the pressurized sealing element of the annular BOP controlling a wellbore pressure , while maintaining a leakage rate less than 1 gallon per minute past the annular BOP sealing element. The testing data files that are included with the Test Summary Report include all data for wellbore pressure, wellbore temperature, test mandrel position, number of tool joints stripped, leak rate past the sealing element, element pressure, and test mandrel speed. Testing information can be summarized as follows: The wellbore pressure window median target during the test was 1000 psi. Temperature was between 40.35ºF and 70.8ºF. The average stripping speed overall was .4 ft/s. The Stroke length was 59". The number of tool joints stripped while maintaining leakrote past the BOP under 1.0 gallons per minute was 1539, with an equivalent length of pipe of 7567 ft. Additional tool joints were stripped for verification, up to a total number of 2001, with an equivalent length of pipe of 9838 ft, during which point leak rate was unable to lower below 1.0 gallons per minute. The closing pressure at the end of the test was 1500 +0/-50 psi, and reached as high as 1766 psi during the additional verification strokes(stroke 1955).

11. Action(s)/Change Order(s) Required During Test:

DISPOSITION

12

- ☑ PASS TO SPEC
- ☐ STOP IMMEDIATELY
- ☐ REDRESS AND RESTART
- ☑ RETURN TO CLIENT
- ☐ REJECT

Responsible Manager	
Name:	Sebastian Nienhuis
Date:	1/20/2014
Initials:	SON

Revisions *-1: Initial Release*
-2: BE 1/21/14 included stroke length and overall stripping length in line 10.

High Temperature Test

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Certificate of Test

Freudenberg Oil & Gas Technologies 13-5/8" x 5,000 psi WellProtek™ Annular-type BOP packer NBR 162, product 10000336-33, was successfully tested for design temperature verification at 275°F in accordance with API 16A Third Edition section 5.8 procedures and acceptance criterion.

Product Details: FO&GT – 13-5/8" – 5,000 psi WellProtek™ Annular NBR 162

Manufacturer:	Freudenberg Oil & Gas Technologies
Part Number:	10000336-33
Batch Number:	139682-1
Compound Description:	NBR Elastomer

Test Parameters

Validation Test Standard:	API 16A Third Edition, High Temperature Test			
BOP Type:	Annular BOP			
BOP Provider:	Weatherford International			
BOP Make:	AXON Pressure Products			
Manufacturers Serial Number:	297251-0045000050075			
Provider Serial Number:	2179264			
Wellbore Temperature, minimum:	136	°C	277	°F
Temperature Class:	D		250	°F
Wellbore Pressure, minimum:	350	bar	5,076	psi
Closing Pressure, minimum:	99	bar	1,445	psi
Test Medium:	Mobiltherm 43			
Hold Duration:	60 Minutes			
FOG WO:	2018 083			

Test Details

Test Performed by	Freudenberg Oil & Gas Technologies
Test Location	Materials Development & Product Testing Lab 4535 Brittmoore Rd. Houston, TX 77041
Internal Test Procedures	SOP-00060, in accordance with API 16A 3rd Edition
Test Completion Date	May 18, 2018
Test Results	No leakage during the hold period of 60 minutes

Authorized by
Michael LoGiudice

Michael LoGiudice

Manager, HOU LAB Facility

C-00014 / 1

Low Temperature

Station I.D.:	TAMUS467
Project No.:	PP096011
Surveyor I.D.:	MMATI
Report I.D.:	2014-04-16-A

DET NORSKE VERITAS

SURVEY REPORT

P.O. Number:	10419	**Date:**	04 Apr 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:	2014-053	**Quantity:**	1
Receiving No:	R2014-0074	**Serial No.:**	13069-1

Equipment Description

Low temperature test on 13 5/8" – 5K Spherical BOP NBR FOG 006-9

Purpose of Survey: Witnessed Low temperature test on 13 5/8" – 5K Spherical BOP NBR FOG 006-9 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 03-15-14 Rev. 1
- 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 / 2014-04-16

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

Certificate of Quality

Per API-16A, every WellProtek™ NBR 162 13-5/8" 5K SBOP Annular Packing Element will be shipped with the required documentation including a FO&GT certificate of quality and a Certificate of Conformance.

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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.