Temperature Rated Ultra

NBR 162

13-5/8” 5K SBOP

Annular Packing Unit

API-16A Design Validation

Customer Data Package

For more information regarding our Temperature Rated Ultra Annular Packing Units please contact:

Freudenberg Oil & Gas Technologies

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www.fogt.com

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Temperature Rated Ultra NBR 162 13-5/8” 5K SBOP

Annular Packing Units

API-16A Design Validation

Summary

Freudenberg Oil & Gas Technologies (FO&GT) Temperature Rated Ultra NBR 162 13-5/8” 5K SBOP Annular Packing Units have completed design validation testing per the following sections of “Specification for Drill-through Equipment”, API 16A 4th Ed.:

- 4.7.3.21 PR1 Fatigue Test, Annular BOP
- 4.7.3.27 PR2 Low Temperature Design Validation, Annular Type BOP
- 4.7.3.29 PR1 and PR2 Extreme High Temperature Design Validation, Annular Type BOP

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

Copies of the test certificates 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.

Temperature Rated Ultra NBR 162 13-5/8” 5K SBOP Annular Packing Units are manufactured in FO&GT’s Fallbrook facility in Houston, Texas. Every unit is factory acceptance tested (FAT) before shipment. An FO&GT product certification of conformance will be sent with each Temperature Rated Ultra Annular Packing Unit, certifying that it meets FO&GT and API-Q1 quality standards and providing the temperature rating.

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 Temperature Rated Ultra, NBR 162, 13-5/8" 5K SBOP Annular Packing Unit

Test	PR1 Section	PR2 Section	PR2 Minimum Performance Criteria
Fatigue	4.7.3.21		26 pressure cycles
Low Temperature		4.7.3.27	3 pressure cycles
Extreme High Temperature	4.7.3.29	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 unit to meet performance requirement level PR1.

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.

PR2 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/PR2 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

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	10108521-33
Performance Requirement (PR) Level	N/A
Bore Size	13-5/8"
Rated Working Pressure	5,000 PSI
Temperature Rating	FGF
Elastomer Type	Nitrile (NBR)
Qualification Test Results	
• Sealing Characteristics	*Not yet Tested*
• Full Closure Pressure Test, Open Hole *Complete Shut-off (CSO)*	2,500 PSI maximum rated working pressure at CSO
• Fatigue	75 cycles @ 1,596 PSI closing pressure
• Stripping	*Not yet Tested*
• Low Temperature	1,502 PSI closing pressure @ high wellbore pressure & 40°F
• Extreme High Temperature	1,494 PSI closing pressure @ 350°F
Size	31.75" O.D. x 15.45" Height
Weight	602 LBS

Material Data Sheet

NBR 162

Physical properties	Typical Values	
Hardness ASTM D 2240, Shore A, Max Readout	79.0 Shore	
Tensile strength ISO 37 / ASTM D 412, S2	3700 Psi	25.5 MPa
Modulus ISO 37 / ASTM D 412, S2		
50% Modulus	370 Psi	2.6 MPa
100% Modulus	620 Psi	4.3 MPa
Elongation at break ISO 37 / ASTM D 412, S2	520.0%	
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 ^{0}C (176^{0}F)	29%	
24h at 80 ^{0}C (176^{0}F)	18%	
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)	-31%	
Elongation at break (ISO 37 / ASTM D 412, S2)	-52%	
Volume change (ISO 1817)	11%	
Change after aging in IRM 901: 70h at 149^{0}C (300^{0}F), 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)	-7.0%	

Listed values are nominal values based on testing performed by FO&GT in accordance with industry testing standards. Actual values may vary.

Temperature Ratings

The Freudenberg FO&GT Temperature Rated Ultra, NBR 162, 13-5/8" 5K SBOP Annular Packing Unit 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

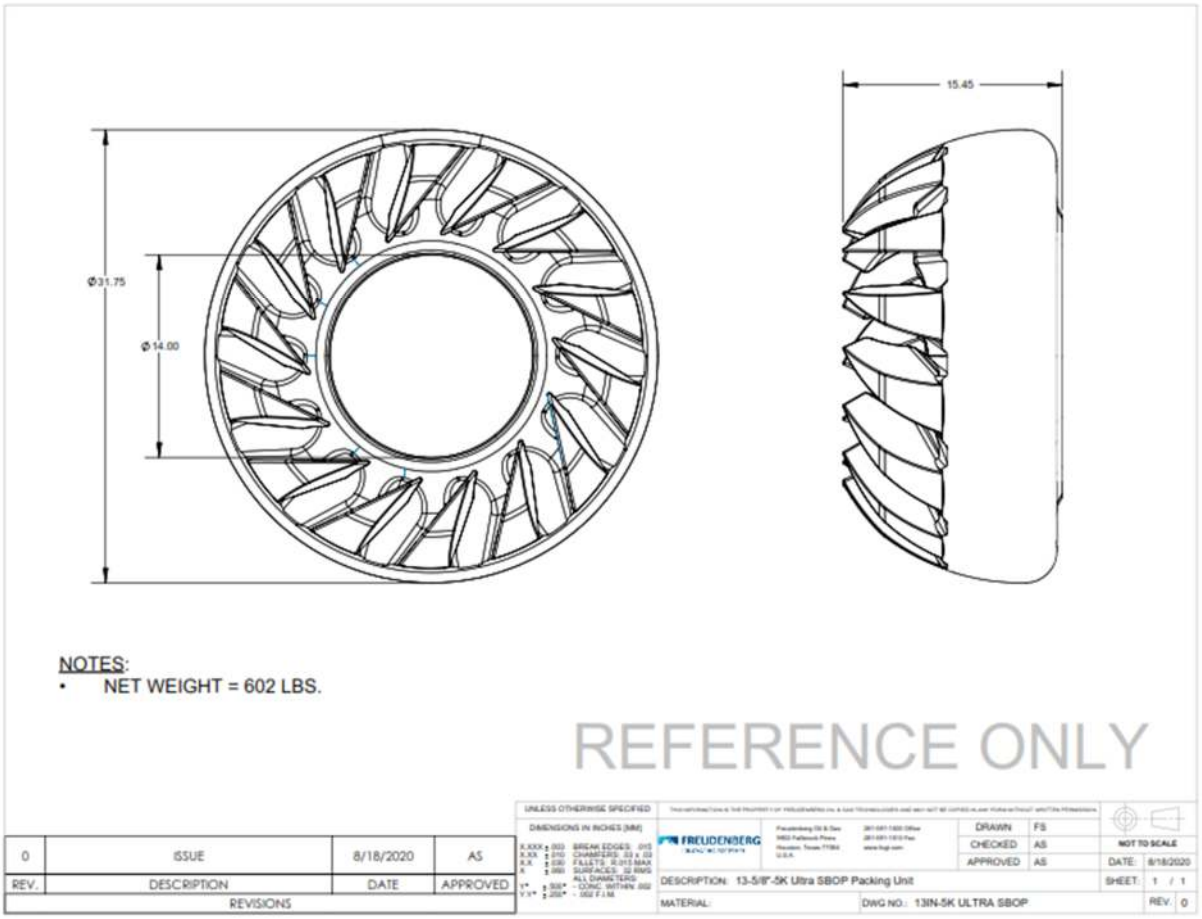
[a] not required for PR1
EXAMPLE Material "FDE" has a low temperature rating of 40 °F, a continuous elevated temperature rating of 240 °F, and an extreme temperature limit of 300 °F.

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

Product Description

FOGT Part #	Element Type	Element Description			Element Style	API Temp. Rating	Temperature Range
		Element Size	Rated Working Pressure	Type			
10108521-33	Temperature Rated Ultra NBR 162	13 5/8”	5,000 psi	Spherical	Shaffer Style	FGF	40F to 350F (4C to 177C)

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 units, 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 tests were performed in accordance with API-16A as part of the FO&GT design validation process. All tests met or exceeded API-16A standards. The list of the tests performed, and their corresponding certificates, are as follows:

Temperature Rated Ultra NBR 162 13-5/8” 5K Annular Packing Units – API-16A 4th Edition

Test	Certificate ID
Fatigue Test	C-00064
High Temperature Test	C-00062
Low Temperature Test	C-00063

Fatigue Test

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Certificate of Test

Freudenberg Oil & Gas Technologies' 13 5/8'' x 5,000 psi NBR 162 Ultra annular packing unit was successfully tested with 525 close and open cycles and 75 low/high pressure tests for fatigue design validation in accordance with API 16A, Fourth Edition, section 4.7.3.21 PR1 procedures and acceptance criterion.

Product Details: FOGT 13 5/8'' x 5,000 psi Ultra Annular Packing Unit NBR 162

Manufacturer:	Freudenberg Oil & Gas Technologies
Part Number:	10108521-33
Batch Number:	7896-7900
Compound Description:	NBR 162 Elastomer

Test Parameters

Validation Test Standard:	API 16A Fourth Edition PR1, Fatigue Test			
BOP Type:	Annular, 13 5/8'' x 5,000 psi			
BOP Model:	BOP Products Series 800 13-5/8" 5K			
BOP Serial Number:	B263-19/BR-008			
Wellbore Low Pressure, minimum:	15	bar	218	psi
Wellbore High Pressure, minimum:	347	bar	5035	psi
Closing Pressure, maximum:	110	bar	1596	psi
Test Medium:	Water			
Hold Duration:	3 minutes			
FOGT Work Order:	2020 142			

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-00125/1, in accordance with API 16A Fourth Edition, PR1
Test Completion Date	August 20, 2020
Test Results	No visible leakage during the hold periods

Authorized by:

Michael LoGiudice

Michael LoGiudice

Manager, HOU LAB Facility

C-00064/2

High Temperature Test

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Certificate of Test

Freudenberg Oil & Gas Technologies' 13 5/8" x 5,000 psi NBR 162 Ultra annular packing unit was successfully tested for Extreme High Temperature design validation at 350°F in accordance with API 16A, Fourth Edition, section 4.7.3.29 PR2 procedures and acceptance criterion.

Product Details: FOGT 13 5/8" x 5,000 psi Ultra Annular Packing Unit NBR 162

Manufacturer:	Freudenberg Oil & Gas Technologies
Part Number:	10108521-33
Batch Number:	2013-2020
Compound Description:	NBR 162 Elastomer

Test Parameters

Validation Test Standard:	API 16A Fourth Edition PR2, Extreme High Temperature Test			
BOP Type:	Annular, 13 5/8" x 5,000 psi			
BOP Model:	BOP Products Series 800 13-5/8" 5K			
BOP Serial Number:	B263-19/BR-008			
Wellbore Temperature, minimum:	177	°C	350	°F
Temperature Class:	F		350	°F
Wellbore Pressure, minimum:	358	bar	5186	psi
Closing Pressure, maximum:	103	bar	1494	psi
Test Medium:	Cosmolubric B230			
Hold Duration:	60 minutes			
FOGT Work Order:	2020 050			

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-00130/1, in accordance with API 16A Fourth Edition, PR2
Test Completion Date	May 19, 2020
Test Results	No leakage during the hold period

Authorized by:

Michael LoGiudice

Michael LoGiudice

Manager, HOU LAB Facility

C-00062/4

Low Temperature

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Certificate of Test

Freudenberg Oil & Gas Technologies' 13 5/8" x 5,000 psi NBR 162 Ultra annular packing unit was successfully tested for low temperature design validation at or under 40°F in accordance with API 16A, Fourth Edition, section 4.7.3.27 PR2 procedures and acceptance criterion.

Product Details: FOGT 13 5/8" x 5,000 psi Ultra Annular Packing Unit NBR 162

Manufacturer:	Freudenberg Oil & Gas Technologies
Part Number:	10108521-33
Batch Number:	2013-2020/201144
Compound Description:	NBR 162 Elastomer

Test Parameters

Validation Test Standard:	API 16A Fourth Edition PR2, Low Temperature Test			
BOP Type:	Annular, 13 5/8" x 5,000 psi			
BOP Model:	BOP Products Series 800 13-5/8" 5K			
BOP Serial Number:	B263-19/BR-008			
Wellbore Temperature, maximum:	4.3	°C	39.8	°F
Temperature Class:	F		40	°F
Wellbore Pressure, minimum:	347	bar	5028	psi
Closing Pressure, maximum:	104	bar	1502	psi
Test Medium:	Ethylene glycol/water 50/50			
Hold Duration:	10 minutes			
FOGT Work Order:	2020 072			

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-00128/1, in accordance with API 16A Fourth Edition, PR2
Test Completion Date	June 15, 2020
Test Results	No leakage during the hold period

Authorized by:

Michael LoGiudice

Michael LoGiudice

Manager, HOU LAB Facility

C-00063/1

Certificate of Quality

Temperature Rated Ultra NBR 162 13-5/8” 5K SBOP Annular Packing Units 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 Freudenberg Temperature Rated Annular Packing Unit listed herein, has been manufactured and inspected in accordance with FO&GT standards.

FO&GT – PE certifies this Freudenberg Temperature Rated Annular Packing Unit 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

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Keep this document for reference!

Product Certification of Conformance

Products will be shipped with a product certification of conformance that includes the temperature rating.

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PRODUCT CERTIFICATION OF CONFORMANCE

Quality Management System – Forms	Issued by: QA	Date: January 26, 2021	Rev: 6

Customer Name: _____ Purchase Order No.: _____

Part Number: _____ Description: _____

QTY	Part No.	Description	Alphanumeric code					Plate No.	Lot & Batch	Exp. Date
			Duro.	Compound	Date Mfg.	WO	Temp. Rating			

Expiration dates valid with proper storage conditions

FOGT Representative _____ Date _____

Products are manufactured in accordance with the Freudenberg Oil & Gas Technologies Quality Management System in compliance with API Q1 and ISO 9001 latest editions.
Products provided meet Freudenberg Oil & Gas Technologies manufacturing requirements and the confirmation provided to the customer based on the customer purchase order.
Product physical properties, in accordance with ASTM standards D2240, D1415, D412, D1414, D395, and D471 for hardness, normal stress strain properties, compression set, and immersion testing respectively, are considered proprietary information of Freudenberg Oil & Gas Technologies
NOTE: Only Freudenberg Oil & Gas Technologies Certified Temperature Rated Products will have a temperature rating listed.