

# Confidential Technical Report

## PHYSICAL TESTING OF ONE SEAL MATERIAL REFERENCE: R-50; CLASS 50 TO CLAUSES OF BS EN 681-1: 1996

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**PHYSICAL TESTING OF ONE SEAL MATERIAL REFERENCE; R-50  
CLASS 50 TO CLAUSES OF BS EN 681-1: 1996**

**1. INTRODUCTION**

Details of the samples supplied and the tests requested are as follows: -

<b>Sample Designations</b>	R-50
<b>Description of Materials Received:</b>	Material in sheet and button form were supplied and allocated the Smithers receipt number SR16608.
<b>Date Received:</b>	11 <sup>th</sup> May 2020
<b>Supplied under Order Number:</b>	AJAY 01/2020 Paid Proforma Ref: 39389 13/5/2020
<b>Tests Requested:</b>	In accordance with table 2 of BS EN 681-1: 1996 (UKAS Accredited)
Hardness (Micro)	BS ISO 48-2
Tensile Strength	BS ISO 37
Elongation at Break	BS ISO 37
Compression Set (72 hrs @ 23°C)	BS ISO 815-1
Compression Set (24 hrs @ 70°C)	BS ISO 815-1
Compression Set (72 hrs @ -10°C)	BS ISO 815-2
Tensile strength, elongation at break and Hardness after accelerated heat ageing	BS ISO 188
Stress Relaxation (7 days @ 23°C)	BS ISO 3384-1
Volume change in water	BS ISO 1817
Ozone resistance	BS ISO 1431-1

## 2. LIMITATIONS

Smithers is a UKAS accredited testing laboratory Number 0067. Note that any opinions or interpretations expressed herein are outside the scope of our UKAS accreditation. The results reported herein relate solely to the samples as received, the materials tested and the methods described. The report shall not be reproduced except in full without approval of Smithers.



Smithers have taken a 'non-binary acceptance based on guard band  $W = U$ ' approach to the application of measurement uncertainty when determining whether the test result conforms to the specification limit, i.e., there are be four possible outcomes: Pass, Conditional Pass, Conditional Fail or Fail, as defined in ILAC G8:09/2019 Guidelines on Decision Rules and Statements of Conformity.

Smithers will destroy all the supplied material(s) relating to this contract six months after the work is completed unless a written request is received within that time that the client wishes to have the material returned.

### 3. EXPERIMENTAL DETAILS

The supplied R-50 material was tested in accordance with BS EN 681-1: 1996 table 2 requirements for audit testing, except as otherwise noted. All testing was carried out at the Shawbury test site. Ambient temperature was maintained at  $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$  and all equipment used was calibrated to the accuracy required in the appropriate standard.

#### 3.1 Micro Hardness

##### 3.1.1 Micro Hardness Unaged (BS EN 681-1 Section 4.2.3)

The Micro IRHD hardness was measurements on a 2mm thick sample taken from the supplied sheet material. All measurements using the following parameters:

- Test Method: BS ISO 48-2: 2018 Method M
- Equipment: Wallace Micro-hardness Tester
- Conditioning Period:  $\geq 3\text{hrs @ } 23 \pm 2^{\circ}\text{C}$  after sample preparation.
- Test Conditions:  $23 \pm 2^{\circ}\text{C}$
- Number of Measurements: 5 readings

##### 3.1.2 Micro Hardness Heat Aged (BS EN 681-1 Section 4.2.6)

The measured test piece detailed in section 3.1.1 was then heat aged to the following parameters before being re-measured:

- Test Method: BS ISO 188: 2011
- Equipment: Air Circulating Oven
- Temperature:  $70 \pm 1^{\circ}\text{C}$
- Ageing Duration: 168 hours
- Post Aged Conditioning Period:  $\geq 16\text{hrs @ } 23 \pm 2^{\circ}\text{C}$  after sample preparation.

**Dates of tests:** 2<sup>nd</sup> to 19<sup>th</sup> June 2020

## 3.2 Tensile Strength and Elongation at Break

### 3.2.1 Unaged Tensile Strength and Elongation at Break (BS EN 681-1 Section 4.2.4)

The tensile strength and elongation at break was measurements on five type 2 dumb-bells that were die stamped from the supplied sheet material in the longitudinal direction of the grain. The following test parameters were used:

- Test Method: BS ISO 37: 2017
- Equipment: Hounsfield Tensile Tester  
Laser Extensometer.
- Conditioning Period:  $\geq 16$ hrs @  $23 \pm 2^\circ\text{C}$  after sample preparation.
- Test Conditions:  $23 \pm 2^\circ\text{C}$
- Test Speed: 500mm/min
- Gauge Length: 20mm

### 3.2.2 Heat Aged Tensile Strength and Elongation at Break (BS EN 681-1 Section 4.2.6)

An additional five type 2 dumb-bells were stamped and tested as detailed in section 3.2.1 after undergoing heat ageing to the following parameters:

- Test Method: BS ISO 188: 2011
- Equipment: Air Circulating Oven
- Temperature:  $70 \pm 1^\circ\text{C}$
- Ageing Duration: 168 hours
- Post Aged Conditioning Period:  $\geq 16$ hrs @  $23 \pm 2^\circ\text{C}$  after sample preparation.

**Dates of tests:** 1<sup>st</sup> June to 19<sup>th</sup> June 2020

### 3.3 Compression Set (BS EN 681-1 Section 4.2.5)

Triplicate moulded type B test buttons supplied by the client, were prepared for each of the required test conditions and the compression sets measured using the tests parameters listed below:

- Test Method: BS ISO 815-1 & 2: 2019
- Compression: 25%
- Lubrication Type: Silicone based oil
- Test Conditions:
  1. 72 hours at  $23 \pm 2^{\circ}\text{C}$
  2. 24 hours at  $70 \pm 1^{\circ}\text{C}$
  3. 72 hours at  $-10 \pm 1^{\circ}\text{C}$
- Post Aged Conditioning Period:
  - 30 minutes @  $23 \pm 2^{\circ}\text{C}$  after release from compression for test condition1 & 2.
  - 30 minutes @  $-10 \pm 1^{\circ}\text{C}$  after release from compression for test condition3.

**Dates of tests:** 4<sup>th</sup> to 12<sup>th</sup> June 2020

### 3.4 Stress Relaxation (BS EN 681-1 Section 4.2.7)

The stress relaxation was measured on triplicate test buttons  $13 \pm 0.5\text{mm}$  by  $6.3 \pm 0.3\text{mm}$  supplied by the client using the following test parameters:-

- Test Method: BS ISO 3384-1: 2019 Method B
- Procedure: Discontinuous
- Test Environment: Air
- Conditioning: Thermal (3 hours @  $70 \pm 1^{\circ}\text{C}$ ) & Mechanical
- Test Temperature:  $23 \pm 2^{\circ}\text{C}$
- Compression:  $25 \pm 2\%$
- Lubrication: Silicone based oil
- Measurement Time Intervals: 0.5hrs, 3hrs, 24hrs, 120hrs (5 days) and 168hrs (7 days)
- Total Duration of Test: 7 days

From the results obtained, the best fit straight line was determined by regression analysis using a logarithmic time scale. The percentage relaxation at 7 days was derived from this straight line. All readings were made using a Shawbury-Wallace compression stress relaxometer.

**Dates of testing:** 17<sup>th</sup> to 26<sup>th</sup> February 2020

### 3.5 Volume Change in Water (BS EN 681-1 Section 4.2.8)

Triplicate test pieces 25 to 30mm square were cut from the supplied test sheets and the volume change was measured using the following parameters:

- Test Method: BS ISO 1817: 2015 (volumetric method),
- Test Conditions: 168hrs at  $70\pm 1^{\circ}\text{C}$  in distilled water
- Post Aged Conditioning Period:  $>10 <30$  minutes @  $23\pm 2^{\circ}\text{C}$  in fresh distilled water.

**Dates of test:** 2<sup>nd</sup> to 10<sup>th</sup> June 2020

### 3.6 Ozone Resistance (BS EN 681-1 Section 4.2.9)

Triplicate test pieces approximately 12mm wide by 100mm long were cut from the sheets supplied and the ozone resistance measured using the following test parameters:

- Test Method: BS ISO 1431-1: 2012
- Strain: 20% - All cut surfaces and clamped sections were painted with an ozone resistance paint.
- Conditioning after Straining: 72 hours @  $23\pm 2^{\circ}\text{C}$
- Test Temperature:  $40\pm 2^{\circ}\text{C}$
- Ozone Concentration:  $50\pm 5$  pphm
- Relative Humidity:  $55\pm 10\%$  RH
- Cabinet Fan: On
- Rotational Carrier: On
- Exposure Period: 48 hours

After exposure, the samples were examined for signs of cracking with the naked eye whilst still strained.

**Date of Testing:** 29<sup>th</sup> May to 3<sup>rd</sup> June 2020

## 4. RESULTS

### 4.1 Micro Hardness

Sample Designation	Hardness (I.R.H.D)	
	Unaged	Aged
R-50	50	51
	51	52
	50	51
	49	52
	51	51
<b>Median</b>	<b>50</b>	<b>51</b>
Specification limit	50 ± 5	-
Status (pass / fail)	<b>Pass</b>	-
Change from original	-	1
Specification maximum	-	+8 / -5
Status (pass / fail)	-	<b>Pass</b>

### 4.2 Tensile Strength and Elongation at Break

Sample Designation	Tensile Strength (MPa)		Elongation at Break (%)	
	Unaged	Aged	Unaged	Aged
R-50	20.4	20.8	494	452
	19.5	20.0	485	436
	18.6	20.8	456	452.0
	22.7	19.1	515	440.0
	22.4	20.2	506	452.0
<b>Median</b>	<b>20.4</b>	<b>20.2</b>	<b>494</b>	<b>452</b>
Specification minimum	9	-	375	-
Status (pass / fail)	<b>Pass</b>	-	<b>Pass</b>	-
% Change from original	-	-1%	-	-9%
Specification maximum	-	-20%	-	+10 / -30
Status (pass / fail)	-	<b>Pass</b>	-	<b>Pass</b>



### 4.3 Compression Set

Sample Designation	Compression Set (%)		
	23°C	70°C	-10°C
R-50	9.3	17.4	21.0
	9.3	17.4	20.9
	8.6	17.2	20.1
<b>Median</b>	<b>9.3</b>	<b>17.4</b>	<b>20.9</b>
Specification maximum Status (pass / fail)	12 <b>Pass</b>	20 <b>Pass</b>	40 <b>Pass</b>

### 4.4 Stress Relaxation

Sample Designation	Stress Relaxation (%) 7 Days
R-50	9.2
	8.6
	9.5
<b>Median</b>	<b>9.2</b>
Specification maximum Status (pass / fail)	14 <b>Pass</b>

### 4.5 Volume Change in Water

Sample Designation	Volume Change (%)
R-50	5.5
	5.6
	5.5
<b>Mean</b>	<b>5.5</b>
Specification maximum Status (pass / fail)	+8 / -1 <b>Pass</b>

### 4.6 Ozone Resistance

Sample Designation	Ozone Observations		
	1	2	3
R-50	No Cracking	No Cracking	No Cracking
Specification maximum	no cracking when viewed without magnification		
Status (pass / fail)	<b>Pass</b>	<b>Pass</b>	<b>Pass</b>

## 5. SUMMARY AND CONCLUSIONS

### MATERIAL R-50

Property	Method	Unit	Spec	Results
Hardness (micro)	BS ISO 48	I.R.H.D.	50±5	50
Tensile Strength	BS ISO 37	MPa	9 min	20.4
Elongation at Break	BS ISO 37	%	375 min	494
<b>Heat Ageing</b>		<b>BS ISO 188</b>		
Hardness Change	BS ISO 48	I.R.H.D.	+8 / -5	+1
Tensile % Change	BS ISO 37	%	-20	-1
Elongation % Change	BS ISO 37	%	+10 / -30	-9
<b>Compression Sets</b>				
Comp Set @ 23°C	BS ISO 815-1	%	12 Max	9.3
Comp Set @ 70°C	BS ISO 815-1	%	20 Max	17.4
Comp Set @ -10°C	BS ISO 815-2	%	40 Max	20.9
Stress Relaxation @ 7 days	BS ISO 3384	%	14 Max	9.2
Volume Change in Water	BS ISO 1817	%	+8 / -1	5.5
Ozone Resistance	BS ISO 1431-1	-	No Cracking	0

The supplied R-50 material pass all the requirements of the clauses Class 50 specified in table 2 of BS EN 681-1: 1996 to which it was tested

Version Number	Submission Date	Description	Reason for changes	Author or Originator
01	24 <sup>TH</sup> JUNE 2020	Original Document	N/A	Helen Amos

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End of Report