TNO Quality Services BV

Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek / Netherlands Organisation for Applied Scientific Research

Return address: P.O. box 6235, 5600 HE Eindhoven, The Netherlands

Beele Engineering BV
To the attn. of Mr. J.A. Beele
Beunkdijk 11
7122 NZ Aalten

De Rondom 1
P.O. Box 6235
5600 HE Eindhoven
The Netherlands

Date
December 20, 2007

Our reference
TQS-RAP-07-3192/gge

E-mail
Ben.vanbaarle@quality.tno.nl

Direct dialling
+31 40 265 03 51

Direct fax
+31 40 265 03 02

Chamber of Commerce Veluwe and Twente
08153361

Projectnummer
E07.0145

Subject
Report Petrol/Diesel tests

Dear Mr. Beele,

Herewith we sent you a brief report concerning the results of the petrol and diesel resistance of FIWA.

Introduction

Beele Engineering ordered TNO Quality Services BV to control the petrol and diesel resistance of FIWA sealant.

Investigation

To control the petrol (aromatic) and diesel (paraffinic) resistance, the FIWA sealant was cured for three weeks. After that period the FIWA was immersed in the swelling liquid for 30 days. In that period the swelling was measured several times. The results were summarized in the table 1. There were no cracks or surface attacks or softening visible on the swollen samples.
Next to it the samples were dried at room temperature, after four days the samples showed a shrinkage to normal dimensions.

Table 1

	Petrol	**Diesel**
Time	**Swelling (%)**	**Swelling (%)**
1 day	18	5
6 days	51	12
14 days	84	18
30 days	92	27
drying	**Drying**	**Drying**
4 days	<5	<15

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Conclusion
The swelling test in petrol and diesel with the FIWA sealant showed that after 30 days the surface was not destroyed by the swelling liquids.

Eindhoven, December 2007

B. van Baarle LPRI
Project manager

TNO Quality Services BV

J.H. Naus, M.Sc.
Authorisation

TNO Industrial Technology

Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek / Netherlands Organisation for Applied Scientific Research

De Rondom 1
P.O. Box 6235
5600 HE Eindhoven
The Netherlands

www.tno.nl

T +31 40 265 00 00
F +31 40 265 03 01

Return address: ;P.O. Box 6235, 5600 HE Eindhoven

Beele Engineering BV
Mr. J.A. Beele
Beunkdijk 11
7122 NZ AALTEN

Date
March 4, 2002

Our reference
11/02.001074/sec

E-mail
J.Havinga@ind.tno.nl

Direct dialing
+31 40 265 09 14

Direct fax
+31 40 265 03 02

Project number
007.60126/01.04

Subject
Influence of gasses on the function of FIWA putty

Dear Mr. Beele,

In one of your projects the question was raised what the influence of methane gas (CH_4) and hydrogen sulphide (H_2S) will be on the RISE system. The RISE systems ends with FIWA putty at both ends and therefore the question can be reduced to the effects of these gasses on the FIWA putty.
Base of the FIWA putty is a silicone sealant. Silicone rubber is not resistant to H_2S and limited resistant to CH_4. This, however, is the case with continuous contact with high concentrations. In the project the concentrations are limited to about 2 ppm and also the exposure is occasional.
At exposure the gas(ses) will start to penetrate the rubber. In the RISE system the thickness of the putty is about 20 mm and therefore, although silicone rubber has a rather high permeability, it will take a lot of time before the gasses will have penetrated the full thickness. During the penetration there might be a little swelling of the material. This, regarding the construction, will at most have a positive influence on the sealing properties. At the moment the exposure stops the gas(ses) will start to migrate out of the rubber and after about the same period as the exposure time the concentration of the gas(ses) in the rubber will be reduced to almost zero.
Silicone rubber can handle very well small swellings and extractions without loss of properties. Therefore it is concluded that such circumstances will have no significant effect on the functionality of the FIWA putty.

Best regards,

J.S. Havinga, B.Sc.
Manager Product Assessment Rubber

TNO Industrial Technology

Schoemakerstraat 97
P.O. Box 6031
2600 JA Delft
The Netherlands

Phone +31 15 2696900
Fax +31 15 2696280
E-mail @ind.tno.nl

Direct dialling
+31 15 2696618

Beele Engineering b.v.
To the attn of Mr. J.A. Beele
Beunkdijk 11
7122 NZ AALTEN

Date
October 30, 2000

Our ref.
BU4.00/039016-1/BB

Subject
chemical and biological attack FIWA

Your letter

Dear Mr. Beele

In answer to your questions the following explanations.

FIWA has been developed as a fire retardant sealant for RISE (Multi Cable Transit) applications. FIWA sealant must be applied to both sides of the transit with a thickness of at least 20 mm. No polymer/elastomer can be used as a sealant for high temperature applications that will fulfill the requirements as regards to the resistance to mentioned fluids, acid- and salt atmospheres, mould growth and solar radiation.

Most promissing polymer is silicone, which is almost inert to acid- and salt atmospheres, solar radiation and biological attack.

Some fluids like petroleum and iso-octane may deteriorate silicone sealant but, when not immersed, fluids will only attack the surface as mentioned in report BU4.99/034419-1/BB, titled "Gasoline resistance of FIWA". In practice no immersion will be applied.

kind regards
TNO Industry

Project Manager
B. van Baarle

Manager Product Evaluation
J.S. Havinga

Enclosures

TNO Institute of Industrial Technology

Schoemakerstraat 97
P.O. Box 6031
2600 JA Delft
The Netherlands

Phone +31 15 2696900
Fax +31 15 2696280
E-mail @ind.tno.nl

Direct dialling
+31 15 2696618

Beele Engineering b.v.
To the attn. of Mr J.A. Beele
Beunkdijk 11
7122 NZ AALTEN

Date
December 21, 1999

Our ref.
BU4.99/034419-1/BB

Your letter

Subject
Gasoline resistance of FIWA
Order 50067/01.01

Dear Mr. Beele,

Herewith we sent you the results of gasoline resistance of FIWA.

Introduction
Beele Engineering ordered the TNO Institute of Industrial Technology to control the gasoline resistance of FIWA putty. The FIWA was already crosslinked and received as a plate material with a diameter of about 80 mm and a height of about 30 mm. The sample number was 991230.

Investigation and results
To control the gasoline resistance, Fuel B (iso-octane/toluene 70/30) was used as swelling liquid. A column of the swelling liquid was placed on the sample. After one week at normal temperature a visual inspection was carried out on the sample. The test with Fuel B is comparable to that of gasoline. The sample showed after one week some swelling at the surface. There were no cracks visible on the sample and no coulouring from the liquid occurred. After conditioning for three days in air at 40 °C just the swelling disappeared. There were no signs of additional shrinking or visible defects.

Conclusion
The test with the sample FIWA showed that it could resist Fuel B for at least one week. In practice the gasoline will be removed much sooner. Therefore it can be concluded that the FIWA putty can be used for RISE cable and pipe penetrations were occasionally contact with gasoline might appear.

Project Manager
B. van Baarle

Manager Product Testing Rubber
J.S. Havinga

Enclosures

TNO Quality Services BV

Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek / Netherlands Organisation for Applied Scientific Research

Return address: P.O. box 6235, 5600 HE Eindhoven, The Netherlands

Beele Engineering BV
Attn. Mr. J.A. Beele
Beunkdijk 11
7122 NZ AALTEN
The Netherlands

De Rondom 1
P.O. Box 6235
5600 HE Eindhoven
The Netherlands

Date
February 13, 2007

Our reference
TQS-RAP-07-335/idl

E-mail
Ben.vanbaarle@tno.nl

Direct dialling
+31 40 265 03 51

Direct fax
+31 40 265 03 02

Project number
E07.0145

Chamber of Commerce Veluwe and Twente
081563361

Subject
Statement of TNO concerning the RISE-system

Dear Mr. Beele,

Herewith we sent you the statement of TNO Quality Services BV concerning the RISE system.

1 INTRODUCTION

We have witnessed the RISE/ NOFIRNO system in an A-0 class deck penetration. The result was that the RISE / NOFIRNO system fulfilled the criteria according to IMO Resolution A.754 (18) maintaining integrity and stability (test report no. 0702-061). In this test the standard sleeves were replaced by NOFIRNO sleeves and the FIWA sealant was replaced by the NOFIRNO sealant. Recently an evaluation was made of the FIWA and the NOFIRNO sealant. The result was that the NOFIRNO sealant shows better (mechanical) properties. The question rises whether in all test (reports), the FIWA sealant can be replaced by the NOFIRNO sealant.

The goal was to evaluate the different test reports in order to give an answer to that question.

2 TEST REPORTS

1 RISE penetrations under artic conditions (February 6, 2006)
2 Electric strength of FIWA sealant (April 19, 2004)
3 Gasoline resistance of FIWA (December 21, 1999)
4 Influence of gasses on the function of FIWA sealant (March 4, 2002)
5 Chemical and biological attack of FIWA (October 30, 2000)
6 Influence of UV on FIWA sealant (March 21, 2003)
7 Helium pressure test on RISE multi cable penetration (March 19, 1999)
8 Adhesion of FIWA sealant to GRP (February 16, 2004)
9 Ageing tests on the RISE system (August 26, 1999)
10 Dynamic cycling test on a RISE transit system (September 19, 2001)

3 EVALUATION OF THE FIWA AND NOFIRNO SEALANT

In table 1 the results of the mechanical and physical properties of the FIWA sealant and the NOFIRNO sealant are summarized.

Table 1 Evaluation FIWA versus NOFIRNO

Property	FIWA sealant	NOFIRNO sealant
Hardness (Shore-A)	33-35	42
Modulus at 100% elongation (MPa)	0.7	0.7
Tensile strength (MPa)	0.85	1.12
Elongation at break (%)	147	214

In both compounds the base polymer is the same silicone polymer with an initial hardness of the gum compound of 20 Shore A. After compounding the hardness differs, the NOFIRNO sealant shows a higher hardness because of the higher filler content and shows also better mechanical properties. This is due to the fact that NOFIRNO sealant contains no large particles in the compound in comparison to the FIWA sealant.

4 EVALUATION OF THE DIFFERENT REPORTS

The reports could be divided in investigations of the chemical or the mechanical behaviour. Most of the properties mentioned in reports 1 - 8 such as temperature resistance, electrical strength, influence of gasses, chemical and biological attack, hot air ageing, cold resistance, UV-behaviour and gasoline resistance are related to the chemical structure of the silicone polymer. These properties hardly change by compounding.
The mechanical properties such as hardness, modulus, tensile strength, elongation, dynamic cycling and adhesion are related to the fillers and filler grade (reports 9, 10 and table 1). As can be seen from the table, the elongation at break of the NOFIRNO sealant is higher than the FIWA sealant. The NOFIRNO sealant shows more flexibility, this gives a better dynamic behaviour. Also a higher hardness gives an improvement of the RISE-NOFIRNO system.

In addition, a pressure test was carried out by using a pressure vessel with an extender ID 207 mm and steel pipe OD 159 mm. The sealing was carried out with NOFIRNO sleeves and NOFIRNO sealant. A pressure test in steps of 0.5 bar up to 2.5 bas gave no leakages.

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5 CONCLUSION

With reference to the TNO reports, the FIWA sealant may be replaced by the NOFIRNO sealant. The mechanical and physical properties of NOFIRNO are the same or better than of the FIWA sealant. Additionally the pressure test up to 2.5 bars gave no leakages.

We trust that this statement of TNO fulfils your question.

Yours faithfully,

Eindhoven, February 2007

B. van Baarle, LPRI
Author

TNO Quality Services BV

J.H. Naus, M.Sc.
Authorisation

TNO Quality Services BV

Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek / Netherlands Organisation for Applied Scientific Research

Return address: P.O. box 6235, 5600 HE Eindhoven, The Netherlands

Beele Engineering BV
Attn. Mr. J.A. Beele
Beunkdijk 11
7122 NZ AALTEN

De Rondom 1
P.O. Box 6235
5600 HE Eindhoven
The Netherlands

Date
February 26, 2007

Our reference
TQS-RAP-07-484/idl

E-mail
ben.vanbaarle@tno.nl

Direct dialling
+31 40 265 03 51

Direct fax
+31 40 265 03 02

Project number
E07.0145

Chamber of Commerce Veluwe and Twente
081563361

Subject
Report adhesion test

Dear Mr. Beele,

Herewith we sent you a brief report concerning an adhesion test by means of a pressure test of a NOFIRNO sealing.

1 INTRODUCTION

Beele Engineering BV in Aalten asked TNO Quality Services to test the adhesion strength of NOFIRNO sealant in a pressure test. In the past this test was carried out with the FIWA sealant. The goal was to investigate the NOFIRNO sealant by using the same method.

2 PRESSURE TEST

The pressure test was carried out in a pressure vessel. At this vessel a cylindrical extender ID 207.3 was mounted to the frame. The inner pipe (conduit) OD159.3 was installed by means of NOFIRNO sleeves and sealed on both sides with 20 mm NOFIRNO sealant (standard RISE sealing system for pipe penetrations).
In steps of 0.5 bars the (water) pressure was raised up to 4 bars. After every 0.5 bar the pressure was held for 15 minutes. In this period a visual inspection was carried out for leakages and/or separation of the adhesion between the extender and the conduit.

Afterwards the (air/water) pressure was raised from 4 bars up to 8 bars. After every 1.0 bar the pressure was held for 30 minutes. In this period a visual inspection was carried out for leakages and/or separation of the adhesion between the extender and the conduit.

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3 TEST RESULTS

Table 1 Pressure test (water)

Bar	Remark:
0.5	No leakages
1.0	No leakages
1.5	No leakages
2.0	No leakages
2.5	No leakages
3.0	No leakages
3.5	No leakages
4.0	No leakages

Table 2 Pressure test (water/air)

Bar	Remark:
4.0	No leakages
5.0	No leakages, only small leakages along the bolts of the rubber packing flange
6.0	No leakages, only small leakages along the bolts of the rubber packing flange
7.0	No leakages, only small leakages along the bolts of the rubber packing flange
8.0	Leakages. Adhesion fails after 28 minutes. A gap of about 30 mm is visible.

As be shown in the tables up to 7 bars there were no leakages through or along the NOFIRNO sealant. At 8 bars a break-out was visible after 28 minutes.

3 CONCLUSION

A pressure test was carried out to test the adhesion strength of the NOFIRNO sealant between the extender and the ducted pipe. Up to 7 bars no leakage was shown.

Yours faithfully,

Eindhoven, February 2007

B. van Baarle, LPRI
Author

TNO Quality Services BV

J.H. Naus, M.Sc.
Authorisation