



Vehicle Certification Agency
1 The Eastgate Office Centre
Eastgate Road
Bristol
BS5 6XX
United Kingdom
Telephone: +44 (0) 117 951 5151
Fax: +44 (0) 117 952 4103
Email: enquiries@vca.gov.uk
www.dft.gov.uk/vca/

TEST REPORT: FMVSS 106 (Brake Hoses)

Amendment 69 FR 76298 (20 December 2004)

§571.106 Section 5 – Hydraulic brake hose, brake hose assemblies, and brake hose end fittings

REPORT/JOB NUMBER: ESN270529

TEST DETAILS

Location of Test	Goodridge, Exeter
Date of Test	14 February 2013 & as attachments
VCA Representative(s)	Matt Claydon
Manufacturer's Representative(s)	Peter Norton, Kelvin Fifer
Reason for Test	Issue of test report for new hose type

MANUFACTURER DETAILS

Manufacturer's Name	GOODRIDGE (UK) Ltd.
Manufacturer's Address	Exeter Airport, Exeter, EX5 2UP, United Kingdom
Model Type & description	-04 PTFE-lined stainless braided hose with end fittings
Category	Not applicable

CONCLUSION

The above mentioned component was tested in accordance with the above mentioned standard and was found to comply in all respects

Signature:
Name: Matt Claydon
Position: Senior Type Approval Engineer
Date: 03 May 2013



TEST REPORT: BRAKE HOSES

FMVSS 106

LIST OF ANNEXES		
ANNEX	No of PAGES	SUBJECT
1	1	Constriction test report
2	4	Expansion and burst test report
3	1	Whip test report
4	1	Tensile strength test report
5	1	Water absorption and burst test report
6	1	Water absorption and tensile strength test report
7	1	Water absorption and whip test report
8	5	Low temperature test report
9	1	Brake fluid compatibility test report
10	4	Ozone test report
11	7	Pressure cycling test report
12	5	Salt spray test report



TEST REPORT: BRAKE HOSES

FMVSS 106

TEST SPECIFICATION AND WORST CASE RATIONALE

Representative samples of assembled hose subjected to all tests. Some tests carried out by external laboratories as detailed below; reports for all tests are attached. Various options for end fittings are offered, but all are made from the same Stainless Steel as those subjected to the corrosion test and are therefore deemed to comply. Hoses are intended for fitment by vehicle manufacturers therefore labelling requirements 5.2.2, 5.2.3 and 5.2.4 do not apply; only 5.2.1 and 5.2.4.1 are assessed.

Tests required

- Construction (witnessed)
- Labelling (witnessed)
- Constriction (witnessed)
- Expansion & burst strength (external laboratory)
- Whip resistance (manufacturer in-house test)
- Tensile strength (witnessed)
- Water absorption & burst strength (witnessed)
- Water absorption & tensile strength (witnessed)
- Water absorption & whip resistance (end of test witnessed)
- Low temperature resistance (external laboratory)
- Brake fluid compatibility, constriction & burst strength (manufacturer in-house test)
- Ozone resistance (external laboratory)
- Dynamic ozone test (external laboratory)
- Pressure cycling and burst (external laboratory)
- End fitting corrosion (end of test witnessed)

COMPONENT SPECIFICATION (as specified in agreed worst case rationale)

Material	Liner: PTFE Braid: 305S15 stainless steel End fittings: 303 stainless steel
Inside diameter	4.93 (+/- 0.50) mm
Outside diameter	8.00 (+/-0.40) mm



TEST REPORT: BRAKE HOSES

FMVSS 106

MANUFACTURER'S DOCUMENTATION

Manufacturer's documentation is complete and reflects the agreed specification for the component tested and covers all variants and versions agreed in the worse-case rationale

Yes

FACILITY AND EQUIPMENT CHECKS

- 1 Generic Risk assessment followed *Insert RA identifier here* PC-RAF001 Yes
- OR
- Specific Risk assessment completed and stored in electronic job folder N/A
- 2 Facilities and test equipment are appropriate Yes
Brief description of test equipment: See below
- 3 Calibration certificates checked and valid, recorded in the following table Yes

Equipment	Serial No.	Calibration data
Tensile test load cell	06-0335-11	Calibrated 14/03/2012
Micrometer used for check constriction gauges	6285173	Calibrated 05/12/2012
Whip test pressure gauge	NG0405	Calibrated 26/07/2012
pH meter	-	Calibrated Jan 2013
Refractometer	-	Calibrated Jan 2013

Other instrumentation used in external laboratory tests is as per the reports from those laboratories.



TEST REPORT: BRAKE HOSES

FMVSS 106

TEST REQUIREMENTS

		Complies Yes/NA
S5.2.1	Stripes are marked on the hose outer as prescribed	Yes
S5.2.2	The hose outer is marked with the information required	N/A
S5.2.3	Packaging is marked with the required information	N/A
S5.2.4	The hose is fitted with a band containing the information required	N/A
S5.2.4.1	End fittings are marked with a symbol which has been registered with the Office of Vehicle Safety Compliance Not all end fitting options checked, manufacturer declares all are appropriately marked.	Yes
S5.3.1	Every inside diameter of the hose is at least 64% of the nominal inside diameter Manufacturer's declared nominal ID: 4.93 mm Measured ID: 5.20 mm Worst-case constriction ID: 3.72 mm	Yes (See Annex 1)
S5.3.2	Hose meets expansion and burst strength test requirements	Yes (See Annex 2)
S5.3.3	Hose does not rupture when subjected to 35 hours on specified flexing machine at pressure of 235psi.	Yes (See Annex 3)



TEST REPORT: BRAKE HOSES

FMVSS 106

S5.3.4	Hose assembly withstands 325 pounds force during slow pull and 370 pounds during fast pull. 4 samples tested: Slow 1 – 425 lbs Slow 2 – 401 lbs Fast 1 – 419 lbs Fast 2 – 424 lbs	Yes (See Annex 4)
S5.3.5	Hose meets burst strength requirements after 70 hours water immersion No leak during 2 minutes at 4000psi No burst at 8000psi	Yes (See Annex 5)
S5.3.6	Hose meets tensile strength requirements after 70 hours water immersion 4 samples tested: Slow 1 – 364 lbs Slow 2 – 366 lbs Fast 1 – 390 lbs Fast 2 – 415 lbs	Yes (See Annex 6)
S5.3.7	Hose meets 35 hours whip resistance requirements after 70 hours water immersion Test stopped after 37h27m without failure.	Yes (See Annex 7)
S5.3.8	Hose conditioned between -45°C and -48°C for 70 hours does not show visible signs of cracking when inspected as specified	Yes (See Annex 8)
S5.3.9	After conditioning filled with specified brake fluid at 120°C for 70 hours, hose meets constriction and burst strength requirements.	Yes (See Annex 9)
S5.3.10	Hose does not show visible cracks under 7x magnification after exposure to ozone for 70 hours at 104°F	Yes (See Annex 10)
S5.3.11	Hose does not show visible cracks without magnification after 48 hour dynamic ozone test	Yes (See Annex 10)



TEST REPORT: BRAKE HOSES

FMVSS 106

The following three tests are carried out sequentially on the same sample:

S5.3.12a	Hose assembly withstands 150 cycles at 146° without leakage See attached report.	Yes (See Annex 11)
S5.3.12b	Hose assembly withstands 4000psi for 2 minutes See attached report.	Yes (See Annex 11)
S5.3.12c	Hose does not burst at a pressure less than 5000psi See attached report.	Yes (See Annex 11)
S5.3.13	End fittings do not show base metal corrosion (except where crimping or labelling has displaced the protective coating) after 24 hours exposure to salt spray as specified. 4 samples inspected, two placed with fitting uppermost, two placed with fitting lowermost.	Yes (See Annex 12)



Reason for Report:

Constriction testing to FMVSS 106 in accordance with S5.3.1 for 4 braid 600-04 hose

Test Requirements:

1. Four sample hose assemblies were subjected to a Constriction testing (after assembly crimping to published spec) – to S6.12 and Plug Gauge method – 6.12.1
2. Test conducted each assy 14/02 – completion witnessed by VCA on site.

Constriction Test Results:-

Using a pin gauge fitting end was gauged minimum bore at 3.22mm - so hoses were cut and hose bore “pin gauged” from cut end into full depth of the collar and tail.

Hose Published bore = 4.93+/- .4mm - Hose batch measured bore = 5.2mm nominal.

Assy 1 – using a pin gauge hose liner under collar and tail was gauged at 3.74mm
Based on 5.2 mm nominal id – FMVSS minimum constriction @ 64% = 3.328mm
Assy within minimum constriction bore.

Assy 2 – using a pin gauge hose liner under collar and tail was gauged at 3.82mm
Based on 5.2 mm nominal id – FMVSS minimum constriction @ 64% = 3.328mm
Assy within minimum constriction bore.

Assy 3 – using a pin gauge hose liner under collar and tail was gauged at 3.72mm
Based on 5.2 mm nominal id – FMVSS minimum constriction @ 64% = 3.328mm
Assy within minimum constriction bore.

Assy 4 – using a pin gauge hose liner under collar and tail was gauged at 3.76mm
Based on 5.2 mm nominal id – FMVSS minimum constriction @ 64% = 3.328mm
Assy within minimum constriction bore.

**Conclusion:**

All Test results satisfy the requirements of FMVSS 106 Constriction test – S5.3.1 – No failures observed.
All samples retained.

Prepared by Pete Norton – Development Engineer Goodridge Ltd

4WARD TESTING LTD

5 Hampers Common Industrial Estate, Petworth, West Sussex, GU28 9NR

Tel: 01798 342240/344323 Fax: 01798 344482

Email: info@4wardtesting.co.uk

Web: www.4wardtesting.co.uk

R1706

4WT NO: 3029 - 32

JOB NO: 2514

CLIENT PO: RQ012250

REPORT NO: R1706

REPORT

on the testing of Hose

Volumetric Expansion and Burst

Supplied by:

Goodridge Ltd
Exeter Airport Business Park
Exeter
EX5 2UP

Report Prepared by:-

LJ Komatsu

4ward Testing Ltd
5 Hampers Common Industrial Estate
Petworth
West Sussex
GU28 9NR
UK

Report on the testing of Hose

Volumetric Expansion and Burst

4ward Testing Ltd were contacted by Goodridge Ltd of Exeter Airport Business Park Exeter EX5 2UP and asked to test Hose to FMVSS-106, Volumetric Expansion and Burst

Identification

Material: VOLEX P BUR Hose
Customer Identification: W173042
Customer Reference: RQ012250
4WT No: 3029 - 3032
Job No: 2514
Date Received: 8/02/2013

Testing Data

The Hose were tested as received from the customer.

Testing was carried out according to FMVSS-106, Section S5.3.2, Volumetric Expansion and Burst

No of hose tested: 4
Internal diameter of hose: 5.2mm
Date of test: 14/2/2013

Test Results

Expansion Test					
Hose No		3029	3030	3031	3032
Applied pressure 1000 PSI	RUN 1 [cc]→	0.30	0.42	0.40	0.20
	RUN2 [cc]→	0.30	0.40	0.35	0.25
	RUN 3 [cc]→	0.25	0.38	0.32	0.20
AVERAGE		0.28	0.40	0.36	0.22
Maximum expansion of free length brake hose [cc/ft] = 0.82		0.31	0.44	0.39	0.24
Pass or Fail		PASS	PASS	PASS	PASS
Applied pressure 1500 PSI	RUN 1 [cc]→	0.42	0.50	0.42	0.40
	RUN2 [cc]→	0.37	0.55	0.55	0.42
	RUN 3 [cc]→	0.40	0.55	0.48	0.45
AVERAGE		0.40	0.53	0.48	0.42
Maximum expansion of free length brake hose [cc/ft] = 1.17		0.44	0.59	0.53	0.47
Pass or Fail		PASS	PASS	PASS	PASS
Applied pressure 2900 PSI	RUN 1 [cc]→	0.80	0.80	0.60	0.70
	RUN2 [cc]→	0.79	0.80	0.60	0.80
	RUN 3 [cc]→	0.87	0.80	0.60	0.70
AVERAGE		0.82	0.80	0.60	0.73
Expansion of free length brake hose [cc/ft] = NOT APPLICABLE		0.90	0.88	0.66	0.81
Burst Test					
4000 PSI applied for 2 minutes followed by 5000 PSI		PASS	PASS	PASS	PASS

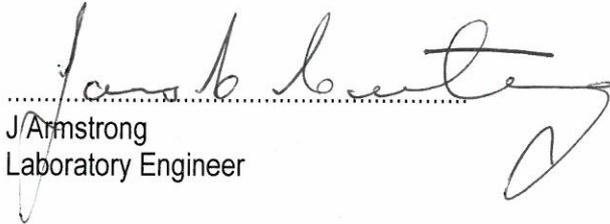
NOTE: Calculations in this table are based on the hose free length measured as 277 mm (0.91 ft).

These results relate only to the material tested

Work recorded by the following personnel:-


.....

K Wilk B Eng Hons
Laboratory Manager


.....

J Armstrong
Laboratory Engineer

Work authorised by the following personnel:-


.....

L Komatsu ACQI
Technical Consultant

**This report shall not be reproduced except in full, without the prior approval of
4ward Testing Ltd in writing.**

.....**END**.....

Reason for Report:

Whip Resistance test to FMVSS 106 in accordance with S5.3.3 for 4 braid 600-04 hose

Test Requirements:

1. Two sample hose assemblies were subjected to a Whip Endurance Test – to S6.3
2. Test start conducted at Goodridge 14/02/13 – witnessed by VCA on site.

Whip Test Results:-

Assy 1- (Test manifold location 2)
Hose: Dash 4 uncovered (OE) 4 wire PTFE
Fittings: Dash 6 female swivel one end – dash 4 fixed male 2nd end – stainless collars and OE (Green) Nylons.
Cut hose length: 395mm measured
Removed @: 106 hours and 10 mins - assembly had not failed at this time –
Date stopped: 19/02/13



Assy 2- (Test manifold location 4)
Hose: Dash 4 uncovered (OE) 4 wire PTFE
Fittings: Dash 6 female swivel one end – dash 4 fixed male 2nd end – stainless collars and OE (Green) Nylons.
Cut hose length: 395mm measured
Failed @: 106 hours and 10 mins
Date stopped: 19/02/13



Conclusion;

Both Test results satisfy the minimum whip test duration requirements of 35 hours, as FMVSS 106.
(All samples retained)

Prepared by Pete Norton – Development Engineer Goodridge Ltd

Reason for Report:

Tensile testing to FMVSS 106 in accordance with S5.3.4 for 4 braid 600-04 hose

Test Requirements:

1. Four, 99mm cut length sample hose assemblies, were subjected to TensileTest – to S6.4
2. Test conducted at Goodridge – completion witnessed by VCA on site.
3. Slow pull at 1” / min’ – requirement: 325lbs (1446N) minimum to separation
4. Fast pull at 2” / min’ – requirement: 370lbs (1646N) minimum to separation

Tensile Test Results:-

Slow Assy 1 – 1891.2N

Slow Assy 2 – 1784.7N

Fast Assy 1 – 1865.3N

Fast Assy 2 – 1887.1N

All testing conducted at Goodridge 14/02/13 witnessed by VCA on site – all samples retained.

Testing completed on a Mecmesin Multitest 2.5 with a AFG 2500N load cell, last calibrated on March 2012.

All output plots recorded and attached.

**Conclusion;**

All Test results satisfy the minimum Tensile Test requirements of FMVSS 106 – S5.3.4

(All samples retained)

Prepared by Pete Norton – Development Engineer Goodridge Ltd

Reason for Report:

Water Absorption and Burst testing to FMVSS 106 in accordance with S5.3.5 for 4 braid 600-04 hose

Test Requirements:

1. Four sample hose assemblies were subjected to a Water Absorption and Burst Test – to S6.2 – having first been water conditioned at 85 degrees C for 70 hours then 30 min’s rest in accordance with S6.5
2. Test conducted for assy 1 and 2 at Goodridge 14/02 – completion witnessed by VCA on site.
- And 15/02 for assy 3 and 4 and self-certified.
3. After conditioning – assemblies subjected to a pressure of 4000psi for 2 mins’ then elevated to over 5000psi and held. Initial ramp rate at 15,000psi / min.

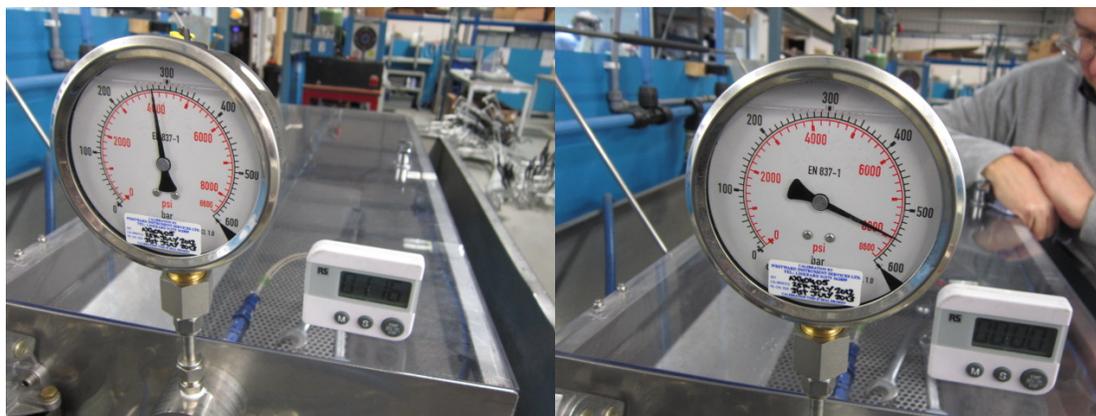
Burst Test Results:-

Assy 1 – 4000psi held for 2 mins – no failures observed
6000psi - no issues (This assembly retained by VCA)

Assy 2 – 4000psi held for 2 mins – no failures observed
8000psi - no issues

Assy 3 – 4000psi held for 2 mins – no failures observed
8000psi - no issues

Assy 4 – 4000psi held for 2 mins – no failures observed
8000psi - no issues



Conclusion;

All Test results satisfy the requirements of FMVSS 106 Water Absorption and Burst – S5.3.5 – No failures observed. (All samples retained, except assy 1)

Reason for Report:

Water Absorption and Tensile testing to FMVSS 106 in accordance with S5.3.6 for 4 braid 600-04 hose

Test Requirements:

1. Four sample hose assemblies were subjected to a Water Absorption and Tensile Test – to S6.4 – having first been water conditioned at 85 degrees C for 70 hours then 30 mins rest in accordance with S6.5
2. Test conducted at Goodridge – completion witnessed by VCA on site.
3. Slow pull at 1” / min’ – requirement: 325lbs (1446N) minimum to separation
4. Fast pull at 2” / min’ – requirement: 370lbs (1646N) minimum to separation

Tensile Test Results:-

Slow Assy 1 – 1623.1N

Slow Assy 2 – 1630.3N

Fast Assy 1 – 1738.6N

Fast Assy 2 – 1846.1N

All testing conducted at Goodridge 14/02/13 witnessed by VCA on site – all samples retained.

Testing completed on a Mecmesin Multitest 2.5 with a AFG 2500N load cell, last calibrated on March 2012.

All output plots recorded and attached.

**Conclusion;**

All Test results satisfy the minimum Tensile Test requirements of FMVSS 106 – S5.3.6

(All samples retained)

Prepared by Pete Norton – Development Engineer Goodridge Ltd

Reason for Report:

Water Absorption and Whip Resistance test to FMVSS 106 in accordance with S5.3.7 for 4 braid 600-04 hose

Test Requirements:

1. Two sample hose assemblies were subjected to a Whip Endurance Test – to S6.3 – having first been water conditioned at 85 degrees C for 70 hours then 30 mins rest in accordance with S6.5
2. Test conducted at Goodridge – completion witnessed by VCA on site.

Whip Test Results:-

Assy 1- (Test manifold location 2)
Hose: Dash 4 uncovered (OE) 4 wire PTFE
Fittings: Dash 6 female swivel one end – dash 4 fixed male 2nd end – stainless collars and OE (Green) Nylons.
Cut hose length: 395mm measured
Removed @: 37 hours and 27 mins - assembly had not failed at this time – (Removed to allow start of non conditioned testing, witnessed by VCA on site)
Date removed: 14/02/13



Assy 2- (Test manifold location 4)
Hose: Dash 4 uncovered (OE) 4 wire PTFE
Fittings: Dash 6 female swivel one end – dash 4 fixed male 2nd end – stainless collars and OE (Green) Nylons.
Cut hose length: 395mm measured
Removed @: 37 hours and 27 mins - assembly had not failed at this time – (Removed to allow start of non conditioned testing, witnessed by VCA on site)
Date removed: 14/02/13



Conclusion;

Both Test results satisfy the minimum whip test duration requirements of 35 hours, as FMVSS 106. (All samples retained)

Prepared by Pete Norton – Development Engineer Goodridge Ltd

parc

product assessment + reliability centre



Unit 10 Caddsdon Industrial Park
Clovelly Road Bideford Devon EX39 3DX
Telephone: +44(0)1237 421255
Facsimile: +44(0) 1237 423541
Email: info@parcsw.co.uk
Web site: www.parcsw.co.uk

TEST REPORT

Customer Confidential

ENVIRONMENTAL TEST REPORT NO. 4805

**GOODRIDGE UK LIMITED
EXETER AIRPORT BUSINESS PARK
FAIR OAK CLOSE
EXETER
DEVON
EX5 2UP**

DATE : 6 MARCH 2013



2379

*This report shall not be reproduced, except in full, without the written approval
of the testing laboratory*

Product Assessment and Reliability Centre Ltd. performs all of its product testing under a rigorous laboratory management system. We are accredited by UKAS to BS EN ISO/IEC 17025:2005, the "General requirements for the competence of testing and calibration laboratories". Details of our UKAS accredited tests and a copy of our UKAS Schedule of Accreditation are available upon request. Tests marked "non-UKAS" are currently not covered by our UKAS 17025:2005 accreditation. All testing, whether UKAS or non-UKAS, is performed within the same laboratory management system and to the same levels of calibration and traceability.

The results contained in this report relate only to the samples submitted.



Unit 10 Caddsdwn Industrial Park
 Clovelly Road Bideford Devon EX39 3DX
 Telephone : +44 (0) 1237 421255
 Facsimile : +44 (0) 1237 423541
 e-mail: info@parcsw.co.uk
 Website: www.parcsw.co.uk

TEST REPORT

Customer Confidential

Report Number: 4805

Issue Number: 1

Date of Issue: 06/03/13

Reason for Re-issue: N/A

Page 1 of 4



2379

Date Samples Arrived	08/02/13	Requested by:	Kelvin Fifer Goodridge UK Ltd Exeter Airport Business Park Fair Oak Close Exeter Devon EX5 2UP
Date Testing Started	19/02/13		
Date Testing Completed	22/02/13		
Customer Purchase Order No:	RQ012155		

Description of equipment under test:

One off brake hose liner

Serial/Identity numbers: N/A

Test Performed:

In accordance with (Test Specification or Standard/Customer supplied test programme)

FMVSS 106 section S5.3.8
 and ref S6.6 and generally in accordance with BS EN 60068-2-1:2007 Test Ab

Process 1 Low temperature storage UKAS

Report Summary:

The sample content was subjected to the test regime outlined above.

The sample was photographed prior to and upon completion of testing.

The sample was subjected to a function test upon completion of testing. This involved wrapping the sample around a mandrel and subjecting the sample to a visual inspection for any cracks or damage.

Disposal of Sample

Returned to customer by courier on 22/02/13

Distribution:

- 1. K.Fifer
- 2. PARC Ltd File

Test Engineer

Name: T.Farnell

Signature:

Approved by:

Name: S.Wort

Signature:

Job Title: Senior Engineer

Results reported in this test report relate only to those samples tested
 Any opinions or interpretations expressed within this report, together with tests marked 'Non UKAS'
 are not included in the UKAS Accreditation Schedule for this Laboratory.

1. Sample Content

Description	Serial Number	Other Identifying numbers/marks
One off brake hose liner	N/A	N/A

2. Test Equipment Used

Test Equipment	PARC Ltd unique ID number	Calibration Due Date
Altitude chamber	385	13/02/14
Room logger	329	10/08/13

3. Initial Inspection

The sample was subjected to an initial visual inspection (non-UKAS) and no obvious signs of cracks or damage were noted.

4. Test Procedure

4.1 Process 1

The sample content was subjected to a low temperature storage test carried out in accordance with FMVSS 106 section S5.3.8 and ref S6.6 and generally in accordance with BS EN 60068-2-1:2007 Test Ab. The test had the following levels:

Temperature: -46°C
Duration: 70 hours
Ramp rate: +/-1°C/min

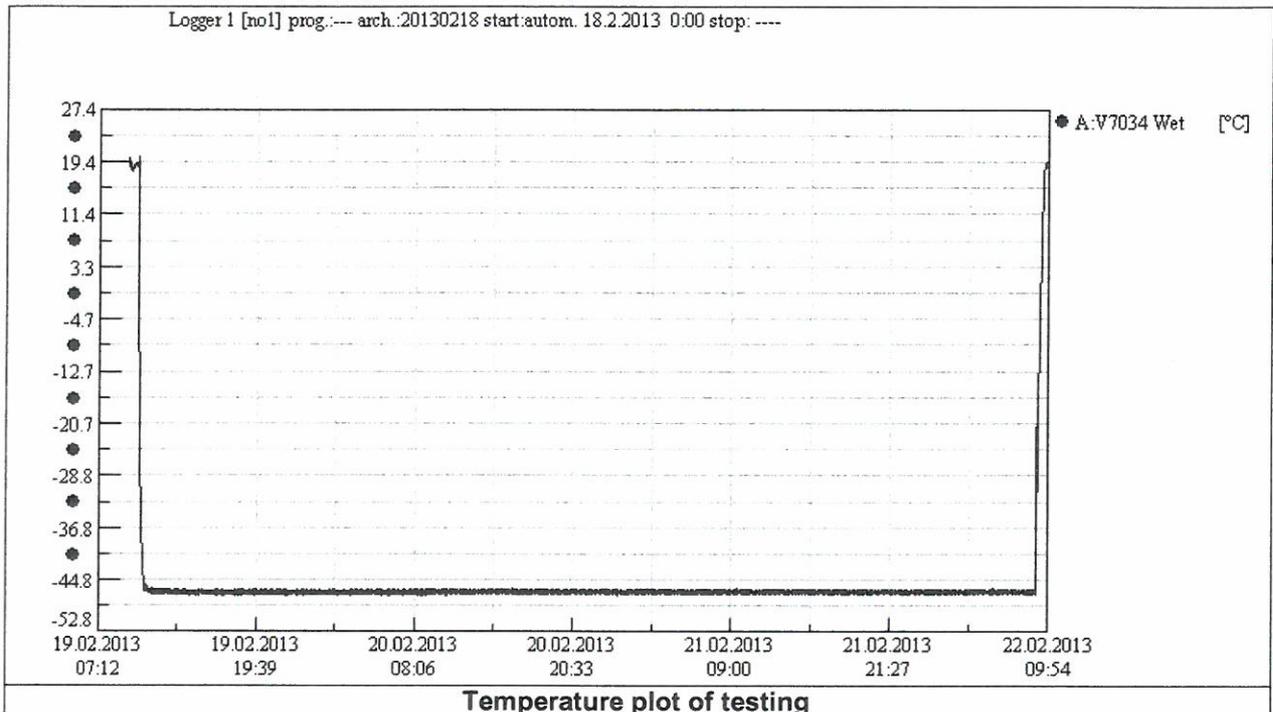
4.1.1 Test Photos



Sample content inside chamber

Intentionally blank

4.1.2 Test Results/plots



No Calibration offset needs to be applied to the above graph.

4.1.3 Function Test

Sample content was subjected to a function test on completion of testing in accordance with customer instructions. The function test involved the sample being wrapped around a mandrel, as seen in the photo below.



5. Post inspection

The sample was subjected to a post visual inspection (non-UKAS). And no obvious signs of damage or cracks were noted.

Results reported in this test report relate only to those samples tested
Any opinions or interpretations expressed within this report, together with tests marked 'Non UKAS'
are not included in the UKAS Accreditation Schedule for this Laboratory.

6. Report Summary

The sample content was subjected to the test regime outlined in this report.

The sample was photographed prior to and upon completion of testing.

The sample was subjected to a function test upon completion of testing. This involved wrapping the sample around a mandrel and subjecting the sample to a visual inspection for any cracks or damage.

END OF REPORT

Reason for Report:

Brake fluid compatibility constriction and burst strength testing to FMVSS 106 in accordance with S5.3.9 for 4 braid 600-04 hose

Test Requirements:

1. Two sample hose assemblies were subjected to brake fluid conditioning using RM-66-04 reference fluid as S5.3.9 - Then Constriction testing to S6.12 and Plug Gauge method – 6.12.1- and Burst testing to S6.2 (On OE hydrostatic test rig – CA01G)
2. Test conducted each assy 22/02 at Goodridge and self-certified.

Burst Test Results:-

Assy 1 – 4000psi held for 2 mins – no failures observed
8000psi - no issues

(assy 1 pics)



Assy 2 – 4000psi held for 2 mins – no failures observed
8000psi - no issues

Constriction Test Results:-

Using a pin gauge, fitting end was gauged minimum bore at 3.22mm - so both hoses were cut and hose bore “pin gauged” from cut end into full depth of the collar and tail.

Hose Published bore = 4.93+/- .4mm - Hose batch measured bore = 5.2mm nominal

Assy 1 – using a pin gauge hose liner under collar and tail was gauged at 3.76mm
Based on 5.2 mm nominal id – FMVSS minimum constriction @ 64% = 3.328mm
Assy within minimum constriction bore.

Assy 2 – using a pin gauge hose liner under collar and tail was gauged at 3.78mm
Based on 5.2 mm nominal id – FMVSS minimum constriction @ 64% = 3.328mm
Assy within minimum constriction bore.

Conclusion:

All Test results satisfy the requirements of FMVSS 106 Brake fluid compatibility constriction and burst strength testing S5.3.9 – No failures observed.

All samples retained.

Prepared by Pete Norton – Development Engineer Goodridge Ltd



SATRA Technology Centre Ltd
Wyndham Way, Telford Way, Kettering
Northamptonshire NN16 8SD
United Kingdom
Tel: +44 (0) 1536 410000
Fax: +44 (0) 1536 410626
e-mail: footwear@satra.co.uk

Firm: Goodridge (UK) Ltd
Fairoak Close
Exeter Airport Business Park
EXETER
EX5 2UP

Job reference: FWT0211908/1307/A/2

Date: 2 May 2013

Samples received: 12 February 2013

Attention of: Kelvin Fifer

Testing completed: 12 April 2013

TECHNICAL SERVICES REPORT

Subject: Testing of hose in accordance with FMVSS 106: S5.3.10, 11 & 12

This report replaces our previous report dated 12 April 2013 and contains more detailed information regarding the tests conducted.

Conditions of Issue:

This report may be forwarded to other parties provided that it is not changed in any way. It must not be published, for example by including it in advertisements, without the prior, written permission of SATRA.

Results given in this report refer only to the samples submitted for analysis and tested by SATRA. Comments are for guidance only. All comments and interpretations are outside the scope of UKAS accreditation and are based on current SATRA knowledge.

A satisfactory test report in no way implies that the product tested is approved by SATRA and no warranty is given as to the performance of the product tested. SATRA shall not be liable for any subsequent loss or damage incurred by the customer as a result of information supplied in the report.

Please note uncertainty of measurement has not been applied to the results in this report. SATRA uncertainty of measurement values are available on request.

Report signed by: Matthew Holt
Materials Technologist
Materials - Testing
On behalf of SATRA Technology Centre Ltd

Technical Services Report

TESTING OF HOSE IN ACCORDANCE WITH FMVSS 106: S5.3.10, 11 & 12

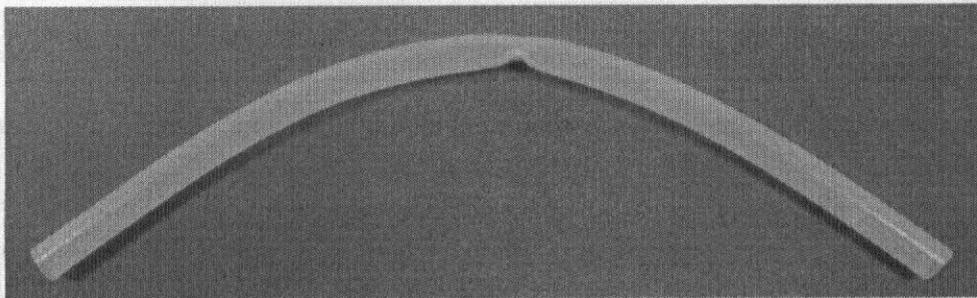
SAMPLES SUBMITTED

REFERENCE

Brake Hose referenced by the customer as: 600-04TUVKB

Image below taken after Dynamic ozone test.

APPLICATION



Automotive brake
hose

Automotive brake
hose

Brake hose with metal male attachments (Sent to MIRA)

COMMENTS AND CONCLUSIONS

The sample submitted when tested in accordance with FMVSS 106: Clause S5.3.10: 2005 Static ozone test, Clause S5.3.11: Dynamic ozone test and Clause S5.3.12: High temperature impulse test have met the minimum requirements.

TESTS CARRIED OUT

- FMVSS 106: Clause S5.3.10: 2005 Static ozone test – Testing was conducted on the 15/2/2013 @ 11:20 – 18/2/2013 @ 9:20. The apparatus used to conduct the test was an 1103 Ozone test chamber manufactured by Hampden (Now owned by SATRA) and a thermographic chart recorder was used to monitor the chamber conditions.
- FMVSS 106: Clause S5.3.11: 2005 Dynamic ozone test – Testing was conducted on the 18/3/2013 @ 9:20 – 20/3/2013 @ 9:20. The apparatus used to conduct the test was an 1103 Ozone test chamber manufactured by Hampden (Now owned by SATRA) and a thermographic chart recorder was used to monitor the chamber conditions. The dynamic test rig was supplied by the customer.
- FMVSS 106: Clause S5.3.12: 2005 High temperature impulse test (Test subcontracted to MIRA)

Firm: Goodridge (UK) Ltd
Job: FWT0211908/1307/A
Date: 2 May 2013

Signed:



Technical Services Report

RESULTS

Test Method	Property	Result	Requirement
FMVSS 106: Clause S5.3.10: 2005	Static ozone test	No cracking when visually examined, following 70 Hrs of static strain around a cylinder, within an ozone atmosphere 1part per million at 40°C	No cracking
FMVSS 106: Clause S5.3.11: 2005	Dynamic ozone test	No cracking when visually examined, following 48 Hrs of cycling, at a rate of 0.3 Hz, within an ozone atmosphere 1part per million at 40°C	No cracking
FMVSS 106: Clause S5.3.12: 2005	High temperature impulse test	No leakages No rupture No bursting @ 5,000PSI plus following 150 cycles at 146 °C, under a pressure cycle of 0-1600PSI held for 2 seconds.	No leakage, rupture or bursting

Technical Services Report

TERMS AND CONDITIONS OF BUSINESS

1. **GENERAL**
Work done or services undertaken are subject to the terms and conditions detailed below and all other conditions, warranties and representations, expressed or implied are hereby excluded.
2. **PRICES**
Prices are based on current material and production costs, exchange rates, duty and freight and are subject to change without notice.
3. **DELIVERY ESTIMATES**
Delivery estimates are made in good faith and date from receipt of a written order and full information to enable us to proceed. While SATRA or its subsidiaries (hereafter referred to as "SATRA") make every effort to fulfil them, such estimates are subject to unforeseen events and if not maintained, cannot give rise to any claim. Offers "ex stock" are subject to prior sale.
4. **CANCELLATION AND RETURNS**
Cancellation of orders for goods, services, training or consultancy is only acceptable by prior agreement of SATRA and a charge will normally be made.
5. **CLAIMS**
Claims for errors, shortages etc should be notified within 10 days of date of receipt. In the event of goods damaged in transit, packing materials should be retained for examination; otherwise no liability can be accepted.
6. **PAYMENT TERMS**
Payment terms are net 21 days from date of invoice. Failure to comply with the terms of payment may result in delayed delivery of goods and services and a review of the Customer's credit account. Should the customer become subject to an administration order, or becomes bankrupt or goes into liquidation, SATRA has a right to cancel any contract and discontinue any work. SATRA reserves the right to adjust US Dollar and Euro sales price where customer exceeds credit terms and where the exchange rate has moved more than 10% since invoicing.
7. **RETENTION OF TITLE**
All goods remain the property of SATRA until paid in full. Under no circumstances will a customer's purchase order override our Retention of Title clause. In the case of software, the ownership of the software remains with SATRA. Payment of invoices in full will entitle the customer to use the software under licence until (a) they cease to be a member of SATRA or (b) they cease trading. In both instances, the licence shall then revert to SATRA.
8. **GUARANTEE**
All goods manufactured by SATRA are guaranteed both as regards material and workmanship. Any part returned carriage paid, within twelve months from date of supply and found defective, will be repaired or replaced at SATRA's option free of charge. SATRA admits no liability for loss, damage or delay consequent on any defect in any goods supplied by SATRA.
9. **TEST REPORTS**
Results given in test reports refer only to samples submitted for analysis and tested by SATRA. A satisfactory test report in no way implies that the product tested is approved by SATRA and no warranty is given as to the performance of the product tested. SATRA shall not be liable for any subsequent loss or damage incurred by the client as a result of information supplied in a test report.
10. **TEST SAMPLES**
Unless otherwise agreed in advance, test samples will be disposed of 6 weeks after the date of the final report. If required, samples can be returned at the Customer's expense.
11. **RESPONSIBILITY**
Every effort is made to ensure accuracy in description, drawings and other information in correspondence, catalogues, etc but no warranty is given in this respect and SATRA shall not be liable for any error therein. SATRA carries out all tests and/or advises only on the basis that the same are carried out, made or given without any responsibility whether for negligence or otherwise. SATRA and its servants or agents will not be liable for any damage or loss direct or indirect of whatsoever kind, whether or not the same results directly or indirectly from negligence on the part of SATRA or its servants or agents.
12. **CONFIDENTIALITY**
Unless specifically excluded in the terms of an individual contract between SATRA and its Customer, the following shall apply to all reports, advice, drawings, photographs, specifications or data:
 - i. The above shall not be disclosed to third parties or used in litigation without the consent of SATRA.
 - ii. Where SATRA has given consent to disclosure, the Customer shall draw the attention of the third party to these terms of business and the basis on which SATRA undertakes test, reporting and advising. The Customer shall indemnify SATRA for any failure to do so.
 - iii. The above items are submitted to the Customer as confidential documents. Confidentiality shall continue to apply after completion of the business, but shall cease to apply to information or knowledge which may come into the public domain.
13. **CONSTRUCTION AND ARBITRATION**
The laws of England shall govern all contracts and the parties submit to exclusive jurisdiction of the courts of England, unless otherwise agreed.

Issue Date: 1st October 2009

Firm: Goodridge (UK) Ltd
Job: FWT0211908/1307/A
Date: 2 May 2013

Signed:



Test Results

Pressure Testing brake hoses

Customer: Holt, Matthew
 SATRA TECHNOLOGY MIRA Contact: Components & Environmental
 CENTRE MIRA Ltd
 Satra House Watling Street
 Rockingham Road Nuneaton
 Kettering Warwickshire
 Northamptonshire CV10 0TU

Nn16 9jh
 matthewh@satra.co.uk

Authority: 31/14132 Witnesses: SATRA TECHNOLOGY
 CENTRE
 Test Date(s) April 8th 2013

Test Objective

Four samples of Goodridge brake hoses were supplied for pressure testing. Two tests were done:

1. Burst Pressure test to 5000 psi.
 2. Pulsing Pressure test – 150 repeats 0 to 1600 psi at 150°C temperature.
- See body of report for details.

Specimen Description

4Off, Braided brake hose. HTIMP-MIRA W173051 300 mm long. See Figure 1 for photograph.

Results Summary

The subject was tested in accordance with the test specification with without deviation. The acceptance criteria of the test specification were:	Met	✓	Not Met	See comments
--	-----	---	---------	--------------

Prepared By:



Geoff Rowlands
 Senior Engineer

Approved By:

pp 

Eamonn Martin
 Department Manager

Date: 02 May 2013

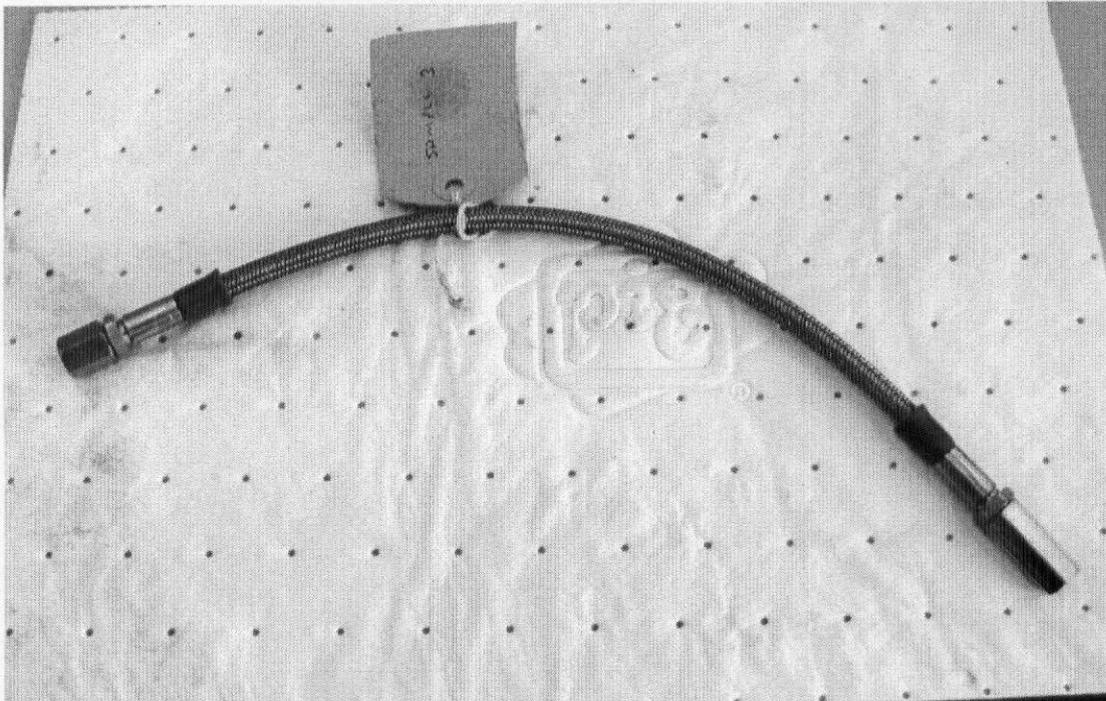


Figure 1 Test sample

Test Details.

1. Burst pressure test.

The test sample was attached to a pressure pump and filled with the test fluid, which was SAE RM-66-04 Compatibility Fluid.

A calibrated pressure transducer was installed in the line to monitor the pressure. The pressure was slowly increased to the test value of 5000 psi and held for a period. Then the pressure was gradually released, and the specimen was examined for signs of leakage.

All four samples were tested in this way. See Figures 3 to 6.

2. Pulsing Pressure test.

The test samples were attached to the pressure pulsing test equipment. This consisted of a high pressure pump, drawing test fluid from a reservoir, which was then connected to a servo valve and then through a hose to the test sample. The test sample was installed in an environmental chamber heated to the test temperature of 150°C. The test sample was allowed to stabilise in the temperature for a few minutes before the test was commenced. The temperature inside the chamber was monitored by use of a thermocouple.

The pressure equipment was then set to run, with the servo valve driven to pulse the pressure to the required level and hold for 2 seconds. The pulses were repeated 150 times and then the sample was inspected for leakage. All four samples were tested in the same way. See Figure 2 for a general view of the test setup.

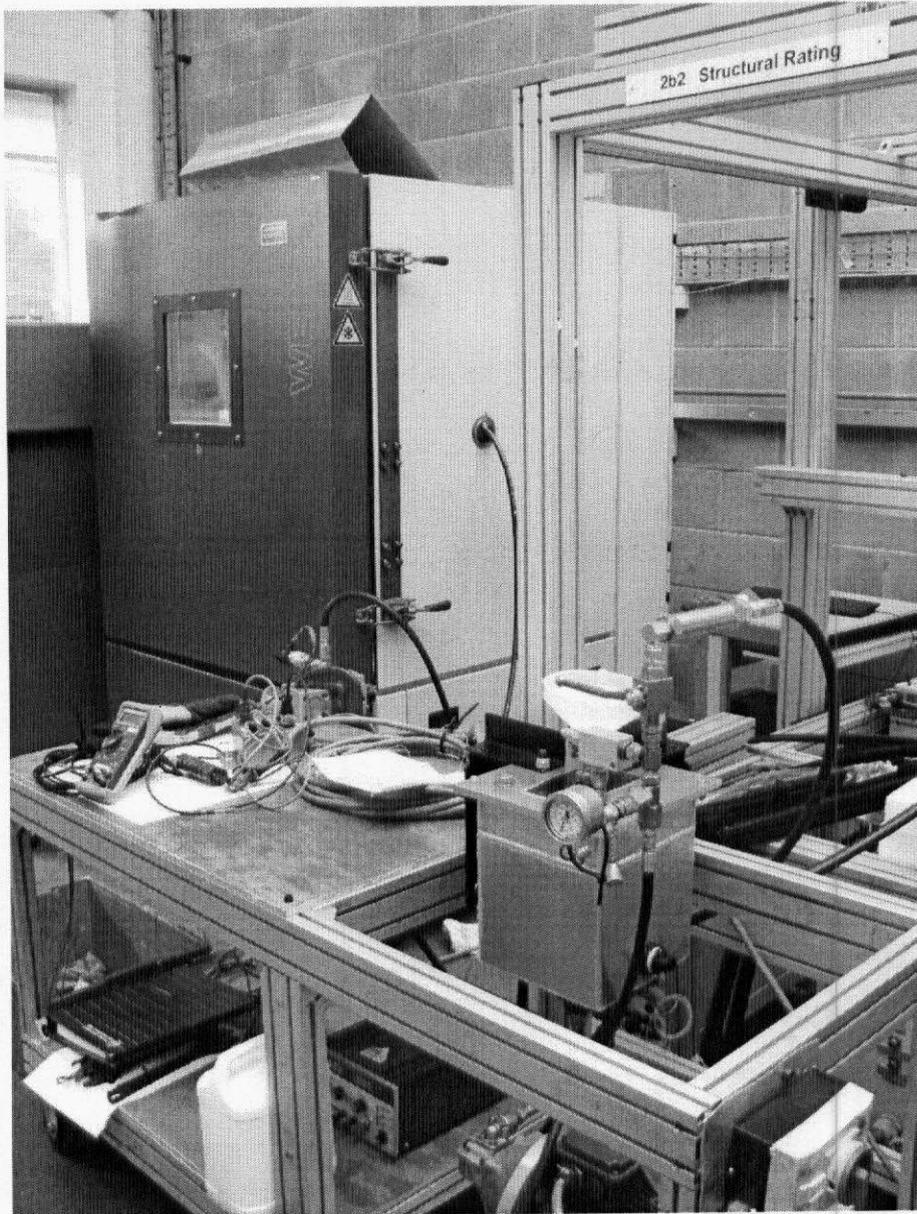


Figure 2 Pressure pulsing equipment and environmental chamber

Test results.

All samples completed the burst pressure test and the pulsing test with no leaks.

Figure 3 to Figure 6 show the burst tests for each sample. Figure 7 and Figure 8 show a pressure pulsing test.

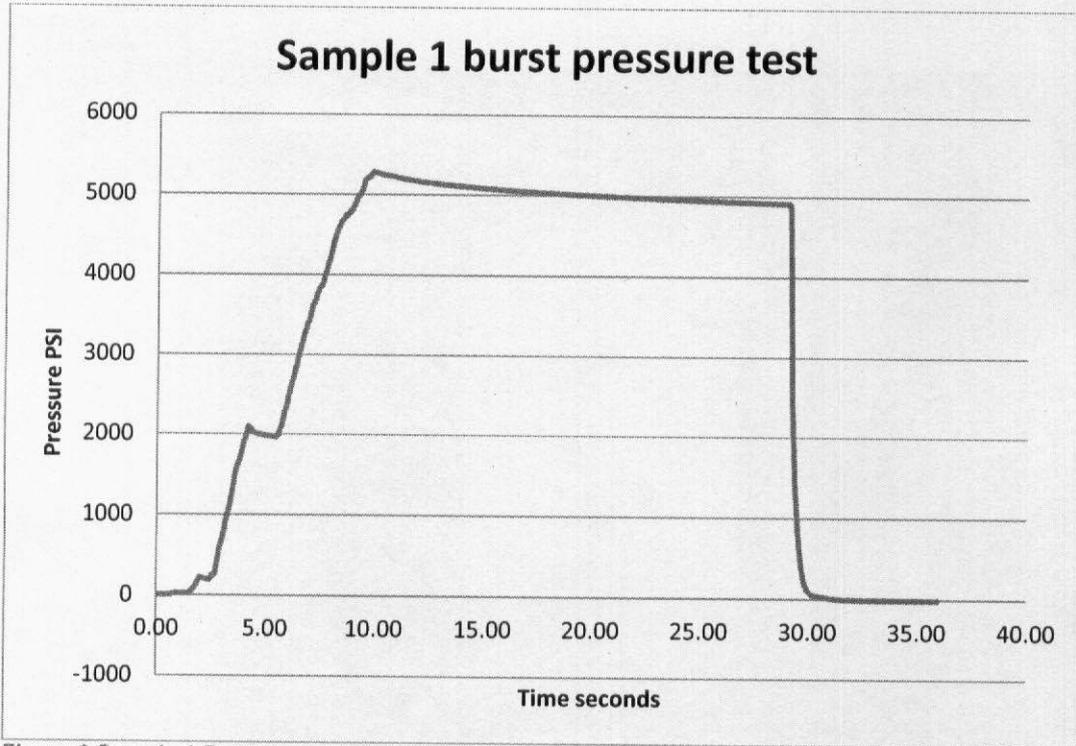


Figure 3 Sample 1 Burst test

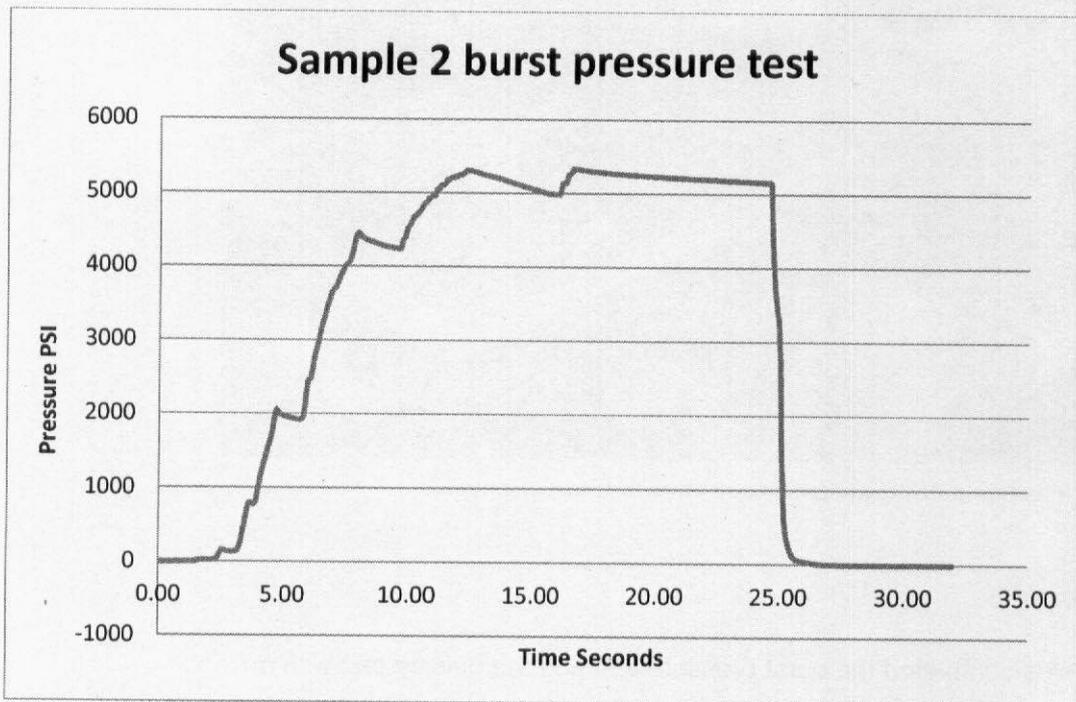


Figure 4 Sample 2 Burst test

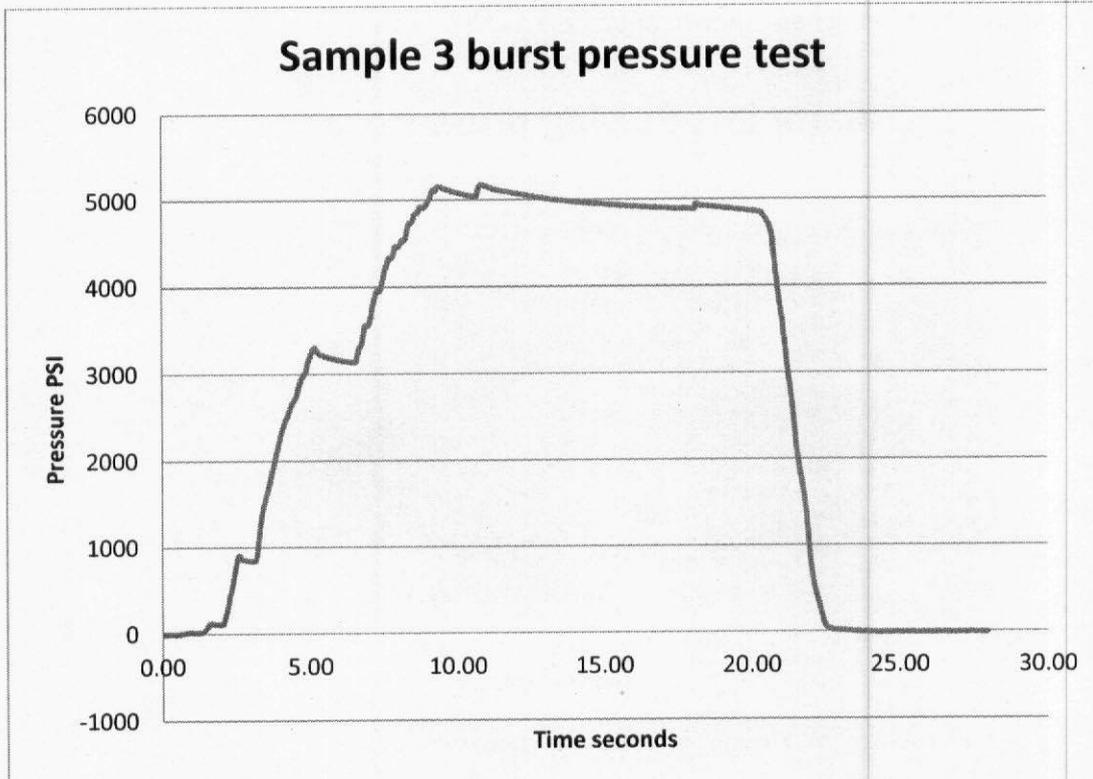


Figure 5 Sample 3 Burst test

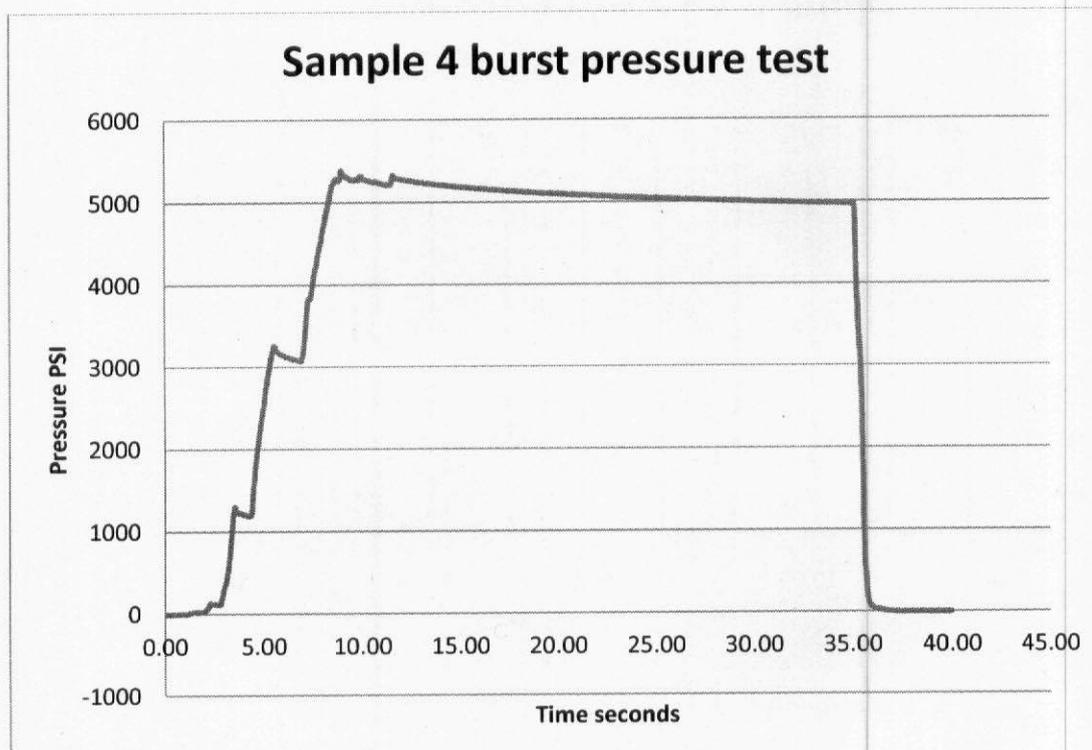


Figure 6 Sample 4 burst test

Pulsing pressure test results are shown for sample 1. All other samples were similar.

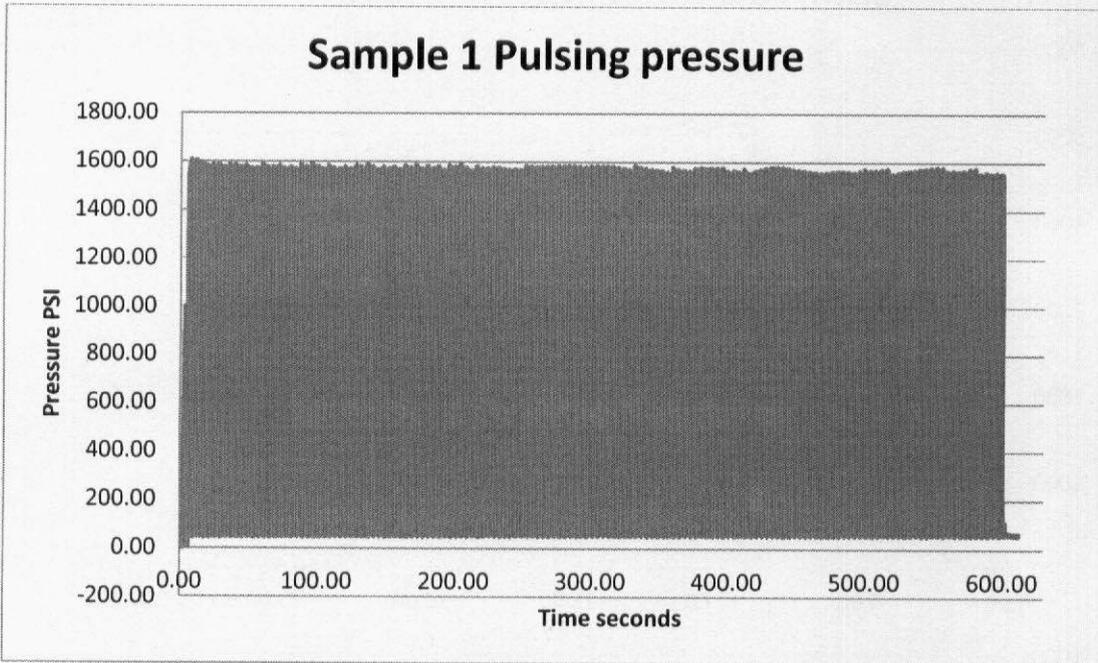


Figure 7 Sample 1 pressure pulsing test, complete time history

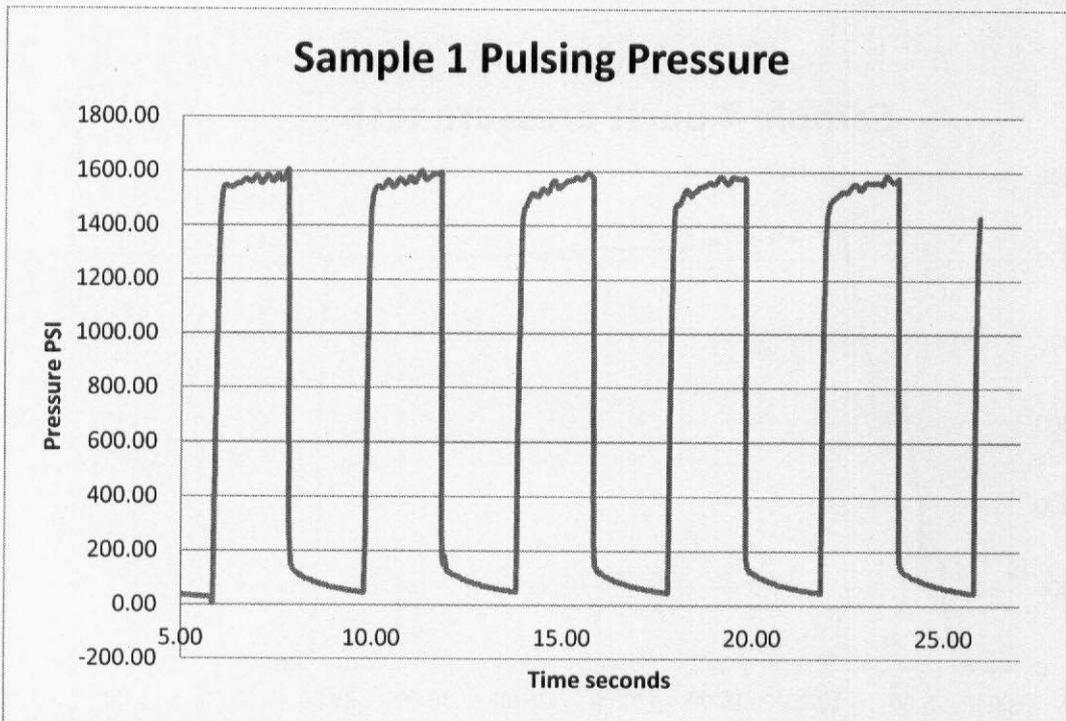


Figure 8 Sample 1 pressure pulsing test - small section.

Appendix 1 Quality Assurance of Measurements

The test equipment is checked on a regular schedule to traceable standards in an International Assurance of Measurements (QAM) procedure. Each item of equipment is issued with a QAM number.

The numbers for the equipment used in these tests were:-

Description	QA Number	Due on
Instron 8800	Q16928	25/04/13
Pressure transmitter	Q22727	07/06/13
Temperature module	Q35100	20/12/13
Digital Voltmeter	Q22109	09/08/13

Channel Sample Rate: 25/sec.

Salt Spray Test Results Report

Date: 14th February 2013

Part numbers tested: 600-04KB (TUV) hose assembly (sub) stainless fittings

Test spec. ASTM B117-09 FMVSS S5.3.13

Test duration: 24 hours
Actual test duration: 24.2 hours

Reference documents: ASTM B117-09 Standard Practice of operation of NSS chambers FMVSS 106 and Referenced SAE J1401

Date: Start date Wednesday 13 February at 1202 hrs
Finish date Thursday 14 February at 1215 hrs

Carried out and reported by: K Fifer

Equipment used :- NSS chamber S1000S

Ascott S1000S chamber Serial number 1419 (date of manufacture 09/2011) and Associated hand instruments for pH levels and salt concentration.
Piccolo pH meter- model Hi 9811 recalibrated Friday 04 January 2013
Ascott Salinity Refractometer - model ACC100 recalibrated Friday 04 January 2013

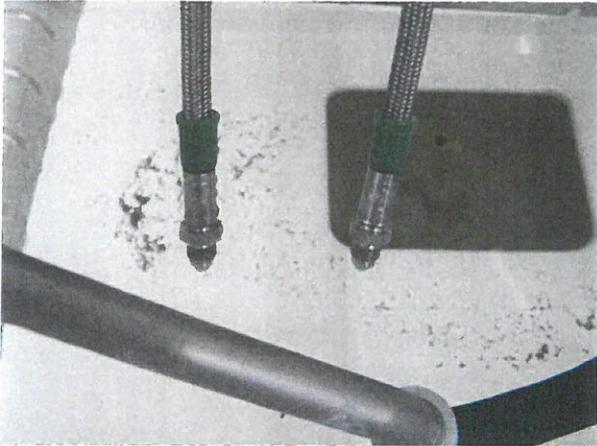
NSS Daily Record Sheet and Control -- Please see attached record sheet

Date	Part Duration Parameters			Fog Collection Parameters				Cabinet Parameters		
	Time Stop	Time Start	Hours Run	QTY	Temp	% Na Cl	pH	Temp	Sat Temp	Water
14/02/2013	1202 13-02	1215 14-02	24.2	108 ml	23° C	5%	6.68	35° C	48.9° C	00.0

Total number of pages in report = 4



Salt Spray Test Results Report



Part numbers tested: -04 hose assy's
(x4)

Placed on test: 946.8 hours (Cabinet
hours run)

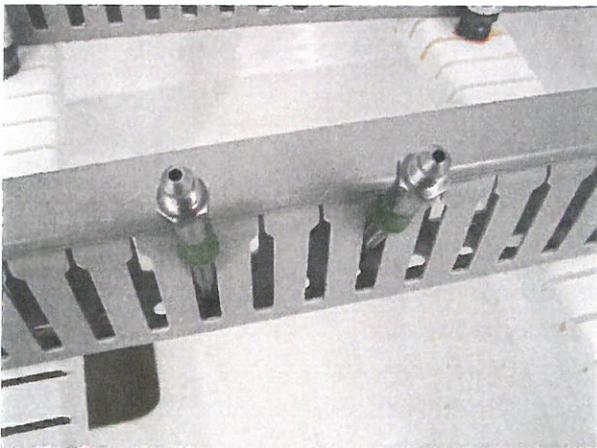
Test started at: 1202 Wednesday 13 Feb

Cabinet Parameters:

Temperature: 35°C

Saturation temp: 48.9°C

Water Quality: 00.0uS

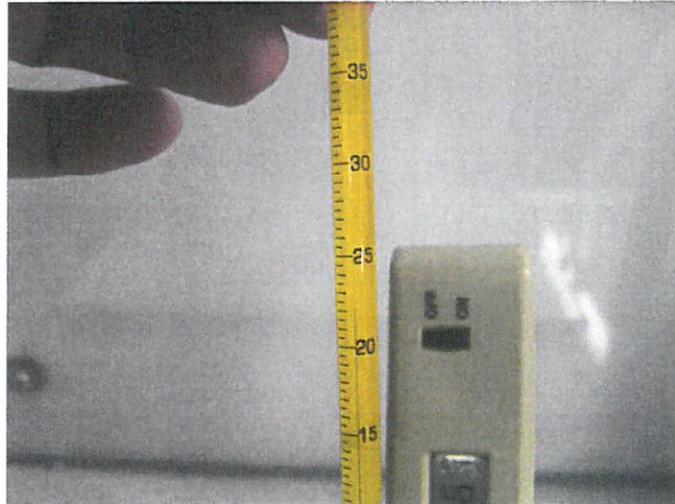
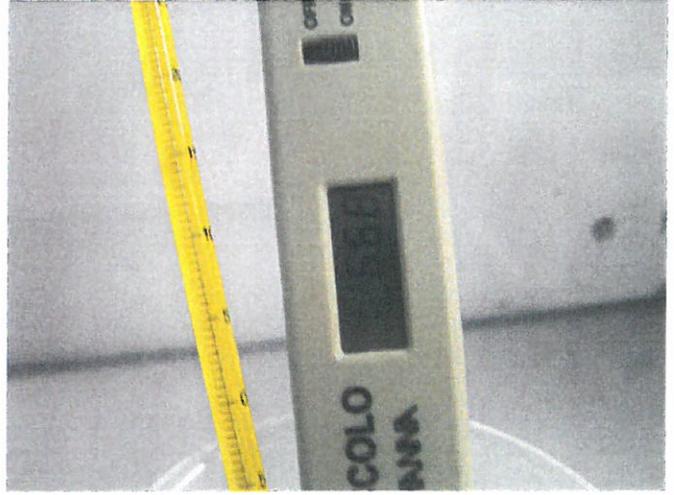
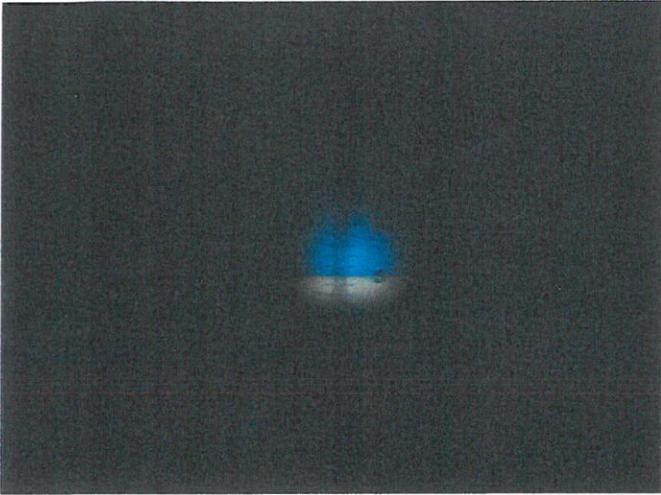


Two items placed in facing down and
two items placed facing up.
The two items placed facing down
exhibited staining on the underside
whilst the two items facing up exhibited
no staining whatsoever.

All associated test parameters normal.
The two items facing down were
inspected and no base corrosion was
found one sample was carefully wiped
to remove staining only and re-
examined with no corrosion found.



Salt Spray Test Results Report



Cabinet restarted at xxxx on xxxx.

Cabinet Parameters:

Temperature: 35°C

Saturation temp: 48.9° C

Water Quality: 00.0uS

Fog Collection Parameters:

Qty: 108ml

Temp: 23°C

% Na Cl : 5%

pH: 6.68

Salt Spray Test Results Report



Items facing down in chamber with one sample polished and re-examined.

Items facing up in chamber during test, no corrosion or staining displayed

