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**Report of Physical Testing on
1/8 inch Hydraulic Brake Hose Assemblies
In accordance With FMVSS 106 (10/1/2007)**

**Prepared For:
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Client Purchase Order Number: Fred


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INTRODUCTION:

This report presents the results of tests performed on 1/8 inch Hydraulic Brake Hose Assemblies. These tests were conducted in accordance with the test requirements of the **Federal Motor Vehicle Safety Standard No. 106 (10-1-07 edition)**. This work was requested by Fred Anderson of BrakeQuip, LLC. The samples were received on May 17, 2011, with the work conducted from May 18, 2011 through May 27, 2011.

SAMPLE DESCRIPTION:

Forty-four (44) hose assemblies were submitted for testing. The assemblies have a free length of approximately 12 inches (305 mm) and are assembled with 10M x 1.0 female connectors on both ends.

TEST RESULTS SUMMARY:

The following are results of testing conducted on the above referenced hydraulic brake hose assemblies in accordance with the test requirements of FMVSS NO. 106 (10/07).

<u>TESTS</u>	<u>REMARKS</u>
<u>Original (Unsoaked Hose)</u>	
Constriction.....	Complies
Volumetric Expansion - Low	Complies
Burst Strength	Complies
Whip Resistance	Complies
Tensile Strength (Fast Pull)	Complies
Tensile Strength (Slow Pull)	Complies
Low Temperature Resistance (Cold Bend)	Complies
Brake Fluid Compatibility	Complies
End Fitting Corrosion Resistance (Salt Spray)	Complies
Ozone Resistance	Complies
Dynamic Ozone Resistance	Complies
Hot Impulse	Complies
<u>Water Absorption (Heat Soak)</u>	
Burst Strength	Complies
Whip Resistance	Complies
Tensile Strength (Slow Pull)	Complies
Tensile Strength (Fast Pull)	Complies

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SAMPLE IDENTIFICATION:**Construction (as supplied by manufacturer):**

Inner tube = PTFE
Outer Cover = PVC
Reinforcing Layer = Stainless steel braid
End Connections = M10 x 1.0 Female

IDENTIFICATION MARKINGS:

Hose Cover – -----BQ FMVSS106 ADR 3.2MM USA-----



180 degrees oppositely prints: ----- BQ DOT ASSEM 12/10 1/8 HL



Fitting (both ends marked the same) – *007



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TEST METHODS AND RESULTS:

Constriction

Hose assemblies were measured for hose constriction by means of a gage plug whose "A" dimension is 0.080 inch in diameter. All hose assemblies permitted the gage to drop of its own weight a distance of three inches into the hose assembly within five seconds and **all were greater than 64 percent** of nominal inside diameter.

FMVSS 106 states that the inside diameter of any section of hydraulic brake hose assembly shall not be less than 64 percent of nominal inside diameter of the hose.

Volumetric Expansion and Burst Strength

The expansion and bursting strengths were determined in accordance with the methods and apparatus specified. The following tabulations show the results of expansion and burst test on four original (un-soaked) hose assemblies and burst test only on four hose assemblies that are soaked for 70-72 hours in distilled water heated to 85° C (185° F).

**Expansion Per Foot of Free Length
in Cubic Centimeters**

Unsoaked Hose Sample No.	1000 Lb./Sq. In.	1500 Lb./Sq. In.	2900 Lb./Sq. In.	Bursting Strength* Lbs./Sq. In.
#1	0.02 cc/ft	0.03 cc/ft	0.09 cc/ft	11,080
#2	0.03 cc/ft	0.03 cc/ft	0.10 cc/ft	18,010
#3	0.02 cc/ft	0.04 cc/ft	0.09 cc/ft	17,190
#4	0.02 cc/ft	0.03 cc/ft	0.08 cc/ft	16,240
Specification Requirement:				
Low Expansion Hose	0.33 Maximum	0.42 Maximum	0.61 Maximum	7,000

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TEST METHODS AND RESULTS: (Cont.)

Soaked Hose Sample No.	Bursting Strength* Lbs./Sq. In.
# 22	7,650
Specification Requirement:	5,000

(*) All assemblies withstood water pressure of 4000 psi for 2 minutes **without rupture** prior to the burst test.

Whip Resistance

Four original hose assemblies, and four that were soaked 70 hours in distilled water heated to 85° C (185° F), were then coupled to the connecting rods of a Whip Test machine conforming to ASTM D571-72. While under constant water pressure, maintained between 235 and 250 psi supplied through the adjustable headers, the samples were subjected to the swirling action caused by the arms rotating at a speed of 800 ± 10 rpm continuously for a period of **40.4 hours** (test discontinued). The apparatus was equipped with a pressure gage installed on the manifold, a pressure regulator to operate a limit switch to stop the machine when the pressure drops, a revolution counter, and an electric timer to indicate elapsed time.

There was **no water leakage** through rupture or leakage of any of the hose assemblies during the period of this test.

FMVSS 106 states the minimum life of any one of the sample hose assemblies, with free length ranging from 8 to 24 inches, running continuously on the flexing machine, shall be 35 hours. Hose armor, if present, shall be removed prior to the test.

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TEST METHODS AND RESULTS (cont.)

Tensile Strength

Tension tests were conducted in a testing machine conforming to ASTM E4 of 1000 pounds capacity. The specimens were secured so that the hose and fittings had a straight centerline corresponding to the machine pull. Results of the tension test for the original (unsoaked) hose and soaked hose in water heated at 85° C (185° F ±3.6° F for a period of 70 hours prior to testing are as follow:

Slow Pull (1 inch/minute) Tensile Strength, lbs

Hose No.	Un-soaked Hose	Hose No.	Soaked Hose
9	590 A	28	513 A
10	540 A	29	566 A

Location of Rupture: A = End Fitting B = Length of Hose

Specification Requirement: 325 lbs. Minimum

Fast Pull (2 inch/minute) Tensile Strength, lbs

Hose No.	Un-soaked Hose	Hose No.	Soaked Hose
13	565 A	32	490 A
14	601 A	33	519 A

Location of Rupture: A = End Fitting B = Length of Hose

Specification Requirement: 370 lbs. Minimum

Low Temperature Resistance

One original hose assembly was conditioned in a cold cabinet in a straight position at -48° C for 70 hours. After conditioning and without removal from the cold cabinet, the hose was bent around a mandrel having a diameter of 2.5 inches. The hose assembly **did not crack or break** per specification.

Specifications state – FMVSS 106 states no visible crack without magnification when bent around 2.5” mandrel after conditioning at -45° C to - 48° C (-49° F to -54° F) for 70 hrs.

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TEST METHODS AND RESULTS (cont.)

Brake Fluid Compatibility

Four brake hose assemblies were filled with SAE RM 66-05 compatibility brake fluid, the lower end sealed and placed in a vertical position in an oven at 120°C (248° F) for 70 hours. After removal from the oven the specimen was allowed to cool to room temperature for 30 minutes and then drained. Constriction was again determined as well as burst strength.

The constriction measurements were again found to be satisfactory as they **exceeded 64 percent of the** nominal inside diameter requirement.

Hose Sample No.	Bursting Strength* psi	Hose. Sample No.	Bursting Strength* psi
36	7,410	38	5,660
37	6,390	39	5,980

Specification Requirement: 5,000 Minimum

(*) All assemblies withstood water pressure of 4000psi for 2 minutes **without rupture** prior to the burst test.

End Fitting Corrosion Resistance

Hose assembly end connections, after being exposed to the 24-hour salt spray in accordance with ASTM B117-97, **exhibited no evidence** of red rust or white corrosion.

Specifications state end fittings shall exhibit no base metal corrosion except where crimping or stamping has caused displacement of the protective coating.

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TEST METHODS AND RESULTS: (Cont.)

Ozone Resistance

Static Ozone

A specimen was wrapped around a three-inch diameter mandrel (approximately eight times the nominal outside diameter of the hose) and the ends were bound with tape where they crossed one another. After conditioning for a period of 24 hours at room temperature and while on the mandrel, the specimen was placed in a cabinet containing air mixed with ozone in the proportion of 100 ± 5 parts of ozone per 100 million parts of air by volume. The ambient temperature in the cabinet was maintained at 40°C (104°F) during the exposure of the specimen.

After the specimen had been exposed to this mixture for a period of 70 hours, the cover of the specimen was examined under 7X magnification ignoring the areas immediately adjacent to or within the area covered by the tape.

The outer cover of the hose was observed at the specified magnification after the above exposure test, and **did not exhibit cracking**.

FMVSS 106 states no visible crack under 7-power magnification ignoring areas immediately adjacent to or within the area covered by binding after conditioning as detailed above.

Dynamic Ozone

Four hose specimens (cut to lengths of $218 \pm 3\text{mm}$ (8.6 ± 0.1 in.)) were subjected to a dynamic ozone exposure test. Samples were assembled on the prescribed SAE test apparatus in a stabilized ozone chamber containing air mixed with ozone in the proportion of 100 ± 5 parts of ozone per 100 million parts of air by volume. The ambient temperature in the cabinet was maintained at 40°C (104°F) during the exposure of the specimen. The flex rate was set at $0.30\text{Hz} \pm 0.05\text{Hz}$ and the hoses were examined for cracks every 24 hrs in the area of worst stress condition, for cracks visible to the eye without magnification.

The test was discontinued following completion of 48 hours when **no cracks were visible** in any of the samples.

Specifications state that the hose shall not show visible cracks after testing a minimum of 48 hours.

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TEST METHODS AND RESULTS: (Cont.)

Hot Impulse

Four hose assemblies were pressure cycled 150 times with fluid and ambient temperatures maintained at 146°C (295°F). The cycles consisted of 1 ± 0.1 minute at 11 MPa + 0.5, -0 MPa (1600 psi + 75, -0 psi) pressure followed by 1 ± 0.1 minute at 0 pressure. The pressure medium was hydraulic brake fluid.

Following the pressure cycling described above the hose assemblies were conditioned at room temperature for 45 minutes minimum and then tested for pressure hold and burst strength.

Sample No.	Bursting Strength* PSI
40	5,590
41	6,240
42	5,630
43	5,470
Performance Requirement	5,000 Minimum

*Prior to the burst test all of the samples withstood water pressure of 4,000psi for 2 minutes **without fluid seepage.**

No sign of fluid seepage, cracking or separation was noted during the impulse cycling.

Specifications state samples shall show no signs of fluid seepage, cracking or separation while being cycled. Following impulse testing, the hose assemblies must meet the original requirements of the pressure hold and burst strength tests.

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CALIBRATED TEST EQUIPMENT:

- PT-171-016 – Digital Caliper Due Date 9/30/2011
- PT-172-036 – Temp/Humidity recorder Due Date 1/20/2012
- PT-172-050 – Mandrel, 3.0” Wood Due Date 7/20/2011
- PT-172-049 – Mandrel 2.0” Due Date 7/20/2011
- PT-172-037 – constriction gauge Due Date 2/24/2012
- PT-173-026 – Fisher Scientific Digital Thermometer Due Date 9/17/2011
- PT-173-033 – Thermotron Temperature/Humidity Chamber Due Date 9/16/2011
- PT-174-001 – Ozone Chamber Calibrated per Use
- PT-174-002 – Salt Spray Cabinet Calibrated per Use
- PT-174-005 – Calipers Due Date 10/15/2011
- PT-174-012 – Pressure Gauge Due Date 10/18/2011
- PT-174-015 – Pressure Transducer Due Date 9/28/2011
- PT-174-020 – Whip Machine Due Date 7/26/2011
- PT-174-029 – Tensile / Compression Tester Due Date 11/2/2011
- PT-175-001 – Temp/Humidity Chamber Oven Due Date 9/16/2011

REMARKS:

The samples will be discarded thirty days from the date on this report unless further instructed by the client

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