



Brake Master Cylinder Fluid Flow Test Procedure

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The purpose of this standard is to objectively quantify the fluid flow rate of brake fluid through a master cylinder assembly.

1.2 Foreword. This procedure outlines a Master Cylinder (MC) flow test bench. The master cylinder and reservoir are evaluated as an assembly without measurement fixtures between the components. Test conditions are established to approximate optimum fluid flow. This test standard shall be used for development and/or validation testing.

The performance metrics validated with this procedure are:

- a. Fluid flow rate through the master cylinder primary port.
- b. Fluid flow rate through the master cylinder secondary port.
- c. Fluid flow rate through both ports.

1.3 Applicability. This standard applies to light or medium duty vehicles equipped with a brake master cylinder.

1.4 Background. Fluid flow rate is recorded across a specific pressure drop. To achieve this pressure drop, the MC reservoir is vented to ambient (0 kPa). A pump is connected to the MC ports and pumps fluid back into the MC reservoir. The pump creates a vacuum that pulls brake fluid through the MC ports. The pump is set to a given pressure to create the required pressure drop.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.1.3 GM Milford Proving Ground, Brake Component Development laboratory or equivalent test facility.

3.2 Equipment.

3.2.1 Test Bench and Capability. A MC flow test bench capable of measuring these performance parameters:

3.2.1.1 Fluid flow rate (cc/s).

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June 2013

Page 1 of 7

3.2.1.2 Output line pressure (kPa).

3.2.1.3 Fluid temperature (°C).

3.2.1.4 Booster vacuum (kPa).

3.2.2 Test Bench Features. The test bench shall incorporate the following features/functions (See Figure A1 and Figure A2.):

3.2.2.1 Flow meter.

3.2.2.2 Pressure transducers (2).

3.2.2.3 Brake Fluid Pump and pump drive.

3.2.2.4 Thermocouple.

3.3 Test Vehicle/Test Piece.

3.3.1 Test parts shall be obtained from the requesting engineer.

3.3.2 New brake actuation system components shall be used.

3.3.3 A minimum of three parts shall be tested.

3.4 Test Time.

Calendar time: 1 to 2 days

Test hours: 8 to 10 hours

Coordination hours: 8 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. One (1) technician trained in the operation of the MC flow test bench.

4 Procedure

4.1 Preparation. Fabricate the appropriate fixture such that the actuation system can be mounted to the test bench.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Ambient test conditions shall be $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

4.2.1.2 Cold test conditions shall be $-20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.2.1 Master cylinder must be actuated for proper fluid flow.

4.2.2.2 Master cylinder must be mounted to a booster.

4.2.2.3 Apply systems used in conjunction with a vacuum pump must be tested at -90.0 kPa vacuum.

4.2.2.4 Apply systems that do not incorporate a vacuum pump must be tested at -67.7 kPa vacuum.

4.3 Instructions.

4.3.1 Ambient Temperature Test.

4.3.1.1 Confirm the brake fluid temperature is $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

4.3.1.2 Adjust the source vacuum to the brake booster to appropriate level per 4.2.4 and maintain the level for the remainder of the test.

4.3.1.3 Open the primary port circuit.

4.3.1.4 Adjust the voltage to the brake fluid pump drive until a 2 kPa change in pressure has been reached.

4.3.1.5 Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.

4.3.1.6 Adjust the voltage to the brake fluid pump drive until a 5 kPa change in pressure has been reached.

4.3.1.7 Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.

4.3.1.8 Adjust the voltage to the brake fluid pump drive until a 10 kPa change in pressure has been reached.

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June 2013

Page 2 of 7

- 4.3.1.9** Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.
- 4.3.1.10** Adjust the voltage to the brake fluid pump drive until a 20 kPa change in pressure has been reached.
- 4.3.1.11** Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.
- 4.3.1.12** Adjust the voltage to the brake fluid pump drive until a 40 kPa change in pressure has been reached.
- 4.3.1.13** Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.
- 4.3.1.14** Close the primary port circuit and open the secondary port circuit.
- 4.3.1.15** Repeat steps 4.3.1.1 through 4.3.1.13.
- 4.3.1.16** Open both the primary and secondary port circuits.
- 4.3.1.17** Repeat steps 4.3.1.1 through 4.3.1.13.
- 4.3.1.18** Document the following metrics:
- 4.3.1.18.1** Primary circuit fluid flow rate.
- 4.3.1.18.2** Secondary circuit fluid flow rate.
- 4.3.1.18.3** Primary and Secondary circuits flow rate.
- 4.3.1.19** Steps 4.3.1.1 through 4.3.1.18.3 signify one test sequence. Repeat Steps 4.3.1.1 through 4.3.1.18.3 two times so that a total of three test sequences have been performed.
- 4.3.2 Cold Temperature Test.**
- 4.3.2.1** Place the MC flow test bench in a cold chamber.
- 4.3.2.2** Soak until the brake fluid maintains a temperature of $-20^{\circ}\text{C} \pm 2^{\circ}\text{C}$.
- 4.3.2.3** Adjust the source vacuum to the brake booster to appropriate level per 4.2.4 and maintain the level for the remainder of the test.
- 4.3.2.4** Open the primary port circuit.
- 4.3.2.5** Adjust the voltage to the brake fluid pump drive until a 2 kPa change in pressure has been reached.
- 4.3.2.6** Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.
- 4.3.2.7** Adjust the voltage to the brake fluid pump drive until a 5 kPa change in pressure has been reached.
- 4.3.2.8** Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.
- 4.3.2.9** Adjust the voltage to the brake fluid pump drive until a 10 kPa change in pressure has been reached.
- 4.3.2.10** Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.
- 4.3.2.11** Adjust the voltage to the brake fluid pump drive until a 20 kPa pressure drop has been reached.
- 4.3.2.12** Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.
- 4.3.2.13** Adjust the voltage to the brake fluid pump drive until a 40 kPa change in pressure has been reached.
- 4.3.2.14** Record the following channels at 100 Hz or greater: output pressure, fluid flow rate, fluid temperature.
- 4.3.2.15** Close the primary port circuit and open the secondary port circuit.
- 4.3.2.16** Repeat steps 4.3.2.3 through 4.3.2.12.
- 4.3.2.17** Open both the primary and secondary port circuits.
- 4.3.2.18** Repeat steps 4.3.2.3 through 4.3.2.12.
- 4.3.2.19** Document the following metrics:
- 4.3.2.19.1** Primary circuit fluid flow rate.
- 4.3.2.19.2** Secondary circuit fluid flow rate.
- 4.3.2.19.3** Primary and Secondary circuits flow rate.
- 4.3.2.20** Steps 4.3.2.2 through 4.3.2.19.3 signify one test sequence. Repeat Steps 4.3.2.2 through 4.3.2.19.3 two times so that a total of three test sequences have been performed.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results.

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June 2013

Page 3 of 7

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