



## **Durability Test of Vacuum Brake Booster and Master Cylinder**

### **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.** Test procedure of vacuum brake boosters.

**1.2 Foreword.** Not applicable.

**1.3 Applicability.** Vacuum brake booster and master cylinder for all vehicles.

### **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 Devices according to the specified tests.**

#### **3.2 Equipment.**

##### **3.2.1 Short Durability Test.**

**3.2.1.1** Two (2) heat devices with eight stations each, one heater and one temperature control.

**3.2.1.2** Four (4) devices per station to record the volume (wheel brake cylinder, etc.)

**3.2.1.3** Eight (8) devices to record the main brake cylinder with brake booster (braking device).

**3.2.1.4** Eight (8) air cylinders with a corresponding supply unit.

**3.2.1.5** Measured value acquisition system.

**3.2.1.6** Online display for all brake pressures, piston rod paths and forces.

**3.2.1.7** Measuring amplifier.

**3.2.1.8** Thirty-Two (32) pressure sensors.

**3.2.1.9** One (1) vacuum pump.

**3.2.1.10** Additional equipment may be required per instruction for the specified tests.

**3.2.2 Brake System Durability Test (AK)-Master Test.** See 4.3.2.

**3.3 Test Vehicle/Test Piece.** At least four brake boosters shall be tested.

**3.4 Test Time.** Not applicable.

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**3.4.1 Short Durability Test:** Two (2) days for measurement before and after test and five days for short test.

**3.4.2 AK-Master Test:** Two (2) days for measurement before and after test and three weeks for Booster AK-Master Test.

**3.5 Test Required Information.** Braking booster characteristic curve.

**3.6 Personnel/Skills.** One (1) Engineer or one technician trained to perform the instructions in 4.3 required.

## 4 Procedure

### 4.1 Preparation.

#### 4.1.1 Short Durability Test.

**4.1.1.1** A maximum of eight main brake cylinders are installed in a heat device along with the brake booster (braking devices) that are actuated by pushrods. The devices corresponding to 3.2.1.1 are installed in a second heat device and connected to the main brake cylinders by the hydraulic brake circuit as in the vehicle.

**4.1.1.2** New released brake fluid shall be used for each test.

**4.1.1.3** The entire brake circuit shall be bled before the test.

**4.1.2 AK-Master Test.** See 4.3.2.

### 4.2 Conditions.

**4.2.1 Environmental Conditions.** Not applicable.

**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 Short Durability Test.

- Number of test cycles: 67 500.
- Test pressure: 90% of control pressure  $p_a$  of initial characteristic curve measurement ( $\pm 3$  bar).
- Vacuum: 0.8 (+0.06 or -0.02) bar.
- Test temperature:  $+100\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ .
- Deflection of piston rod:  $\pm 3$  from zero position.
- The volume absorber device shall be arranged such that the brake unit under test reaches 90% kneepoint-pressure at 2/3 of its total stroke.

#### 4.2.2.2 Simulated Durability Test According to AK-Master.

- Hydraulic Pressure ( $P_A$ ): in the tandem main brake cylinder corresponding to the control point of the brake device.
- Rear brake circuit (DK): in the tandem main brake cylinder.
- Apply with normal pressure (LW-Normal): Stress cycle corresponding to normal braking (only pressure build-up and reduction).
- Apply with Antilock Brake System (LW-ABS): Test using a synthetically determined ABS control process for the test bench load of the braking device assembly. The number of stress cycles and test time do not reflect the field load of the ABS system in the vehicle.

**4.2.2.2.1** The pressures on the consumers and connections with the tandem main brake cylinder as well as the simulation of the control cycles from modulating the pressure at the consumers with a hydraulic control unit shall be taken from Table 1 and Figure 1.

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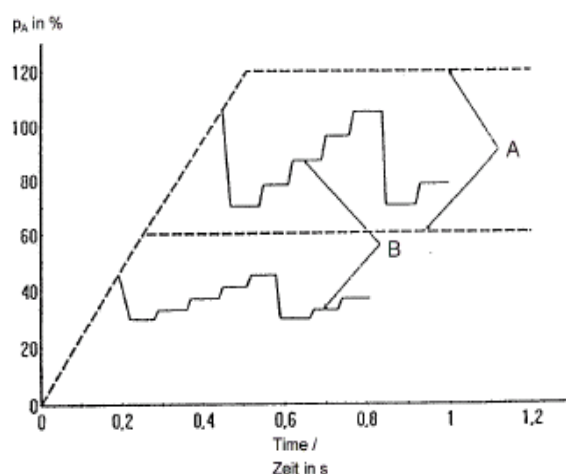
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Table 1: Actuation and Control Pressures with Permissible Tolerances

| ABS Cycle                              | Controlled Pressure in the Consumers              | Pressure in Tandem Main Cylinder prior to Control |
|----------------------------------------|---------------------------------------------------|---------------------------------------------------|
| 120% $P_A$<br>High pressure modulation | Upper limit: 105% $P_A$<br>Lower limit: 70% $P_A$ | 120 (+5)%<br>of the pressure at control point DK  |
| 120% $P_A$<br>Low pressure modulation  | Upper limit: 50% $P_A$<br>Lower limit: 30% $P_A$  | 120 (+5)%<br>of the pressure at control point DK  |
| 60% $P_A$                              | Upper limit: 45% $P_A$<br>Lower limit: 30% $P_A$  | 60 (+5)%<br>of the pressure at control point DK   |



A - Constant tandem main brake cylinder pressure.

B – Controlled pressure in the consumer.

Figure 1: Control Scheme for ABS Braking

**4.2.2.2.2** A controlled braking cycle (= one ABS stress cycle) consists of several control cycles.

One (1) control cycle (whose parameters depend on the system) consists of:

- One (1) pressure reduction pulse and,
- Four (4)  $\pm 1$  pressure build-up pulses.

The interval between the pulses is 70 ms.

The control time is:

- 5 s at +23 °C  $\pm$  5 °C and heat +100 °C  $\pm$  2 °C and +120 °C  $\pm$  2 °C.
- 15 s under cold 30 °C  $\pm$  2 °C and -40 °C  $\pm$  2 °C.

**4.2.2.2.3** A drop or rise in the controlled pressure of  $\leq 15$  bar during control is permissible; all circuits are controlled simultaneously.

**4.2.2.2.4** The pulsation of force on the piston rod during the controls shall be set to closely approximate vehicle conditions. Reference value:  $\leq 300$  N.

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