



## DRIVE Durability Test for Brake Systems

### 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 method to evaluate brake performance under normal driving conditions.

**1.2 Foreword.** The **Drive** Test is separated into three modules, each focused on a particular brake performance metric. Requirements (e.g., drag torque) mentioned in this GMW are recommended values based on a long experience by car testing to avoid customer complains. For further requirements see VTS paragraphs.

**Module I:** Focus on wear; driven four times in a week. See Appendix A for a description of the route.

**Module II:** Focus on noise; driven one time in a week. See Appendix B for a description of the route.

**Module III:** Focus on wash out, lateral run out and thickness variation to evaluate judder and drag torque. Evaluation should be done at Proving Ground Dudenhofen. See Appendix C.

The **Drive** modules should be performed in the order required in the test request. Module III is typically run first.

Brake lining life may be predicted by dynamometer wear versus temperature data or from brake data obtained during proving ground vehicle durability testing combined with wear models. Brake noise may be evaluated with dynamometer or vehicle objective noise tests.

This standard should only be used for wear measurements and noise ratings when other data are not available or this standard has been requested by the program. Refer to GMW15319 Subjective Brake Noise Evaluation for noise rating definitions.

For the targets for Wear see Appendix D, Figure D1. For the targets for Noise see Appendix D, Figure D2.

**1.3 Applicability.** This standard is applicable to all passenger vehicles and light trucks for low-metallic brake lining applications only. This standard is not applicable with Non-Asbestos Organic (NAO) material front applications. This standard may be applicable to applications with low-metallic front linings and NAO rear lining, if requested. Module III is also applicable for NAO linings to detect judder and thickness variations.

### 2 References

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

#### 2.1 External Standards/Specifications.

None

#### 2.2 GM Standards/Specifications.

GMW15102                      GMW15319

#### 2.3 Additional References.

- Best Practices - The supplier shall work with the GM responsible engineer to comprehend this requirement.
- Global Document Management System.
- Vehicle Subsystem Technical Specification.

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### 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 Proving Ground or suitable test areas for Module III.

**3.1.4** Open roads for durability run for Module I and Module II.

**3.1.5** Twelve percent (12%) grade ramp.

#### 3.2 Equipment.

**3.2.1** Accelerometer.

**3.2.2** Brake Rotor/Drum Thermocouples or Brake Lining Thermocouples. Rotor or drum temperature may use surface or embedded thermocouples. Linings may use embedded thermocouples. The measurement of the brake temperatures may be made with an external thermocouple.

**3.2.3** Brake Line Pressure Gauge.

**3.2.4** Brake Line Pressure Transducers. (Optional)

**3.2.5** Calibration Record. All instrumentation is to be calibrated as required. Record instrumentation details and calibration dates in the testing records.

#### 3.3 Test Vehicle/Test Piece.

**3.3.1** The specific vehicle chosen for testing should be representative with respect to brake system, tires, suspension and mass distribution properties.

**3.3.2** If equipped with an antilock brake system (ABS) or other braking control systems, these systems should be correctly calibrated for the vehicle and tire/wheel units and should be functional during test.

#### 3.4 Test Time.

Calendar time: 40 days (Module I through III)

Test hours: 7 hours each day

Coordination hours: 24 hours

#### 3.5 Test Required Information.

**3.5.1** The brake system should be in new condition. If the brake hardware is new production-intent, the hardware on the vehicle can be tested in its current condition. New brake hardware (linings and rotors/drums) may be installed if requested by the test engineer.

**3.5.2** The tires for the testing should be in new condition.

**3.5.3** The brake system is a safety system and may under no circumstances feel insufficient during the test.

**3.5.4** If new driving situations are found that are critical for noise and or judder, these situation should be noted in the test record.

**3.6 Personnel/Skills.** An experienced, trained brake tester capable of performing the vehicle setup and driving instructions is required.

### 4 Procedure

#### 4.1 Preparation.

**4.1.1** Document information about the vehicle (year, model, style, engine, powertrain), the brake system components, and tires (size, make, type, and test pressure) in the test record.

**4.1.2** Thermocouple brake rotors, drums or linings as requested.

**4.1.3** Measure initial thickness of all brake linings, rotors, and drums. Indicate the locations of the measurements in the test record.

**4.1.4** Calibrate the thermocouples.

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**4.1.5** Install the brake components and check all brake adjustments.

**4.1.6** If the brake line pressure gauge or the optional brake line pressure transducers are requested, perform the following:

**4.1.6.1** Install the instrumentation needed to perform a floor check: pedal force, accelerometer, booster vacuum transducers (directly at the booster inlet) and data acquisition system. Perform a floor check.

**4.1.6.2** Install brake line pressure transducers, if requested and perform a floor check.

**4.1.6.3** Compare the pedal travel at 90 N pedal forces in the floor check with line pressure transducers to the same travel in the floor check before the installation of brake line pressure transducers. If the pedal travel increased, use floor checks and brake bleeds, as required, to restore pedal travel to the pre-instrumentation level.

**4.1.7** Complete the installation of instrumentation.

**4.1.8** Ensure that correct tire size and make are fitted. Set tire pressure as specified for specific vehicle test weight.

**4.1.9** If performing Module III first, perform a brake burnish following instructions from the test engineer. The default brake burnish is the burnish specified in GMW15102. The brake burnish should be done with vehicle loaded to gross vehicle weight rating (GVWR).

**4.1.10** Measure the vehicle test weights and per wheel weight distributions. The vehicle weight should be the heaviest curb vehicle weight (100% Option) for the tested brake size, plus driver, plus 1/1 fuel tank, plus 60 kg (luggage), except for delivery vans that should be at 2/3 maximum payload.

**4.1.11** Perform subjective evaluation by development engineer if complaint noise and/or brake feel is noted by the drivers.

## **4.2 Conditions.**

**4.2.1 Environmental Conditions.** The ambient temperature for testing is from -15 °C up to +35 °C which are the ambient temperatures in Germany.

**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** Radio off during testing.

**4.2.2.2** All windows should be open a minimum of 15 cm.

**4.2.2.3** Air conditioning fan setting restricted to off or low position during testing.

**4.2.2.4** Do not overuse the engine brake due to consideration of the traffic.

## **4.3 Instructions.**

**4.3.1** The open road test modules should be run following instructions applied by test facility. Appendices A and B provide outlines of the schedules. Obtain maps and any additional instructions from the test facility. Appendix C has the Proving Ground Module III test instructions.

**4.3.2** One time per week, a wet brake test is to be performed before starting a Module II schedule. The vehicle should be run through a water splash to wet the rotors, drums and linings on front and rear brakes. Then park the vehicle for a 12 h soak (overnight). Perform the following tests with cold brakes after the 12 h soak. Appendix E, Figure E1 is a summary of 4.3.2.1 through 4.3.2.3.

**4.3.2.1** Make four cold brake applies with a speed <10 km/h and a deceleration of <0.1G.

**4.3.2.2** Make two brake applies with vehicle in reverse with a speed <10 km/h and a deceleration of <0.1G.

**4.3.2.3** Drive to a 12% ramp. Test vehicle in both a nose up and nose down position for brake groan noise with both the service brake apply and the emergency/park brake apply. Also observe the grade holding performance of the emergency/park brake.

**4.3.3** Run the modules in the requested order until 10 000 km of usage has been accumulated, unless otherwise specified in the test request.

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The Suggested Test Order:

- a. Module III.
- b. Module I and Module II repeating until 10 000 km are accumulated. Once per week run tests in 4.3.2 before a Module II schedule.

**4.3.4** Document test information including total elapsed test time, weather conditions, etc. See example reporting sheet for ratings and information in Appendix G in Figures G1 and G2.

**4.3.5** Record subjective noise ratings during the appropriate schedules as described in the subjective brake noise procedure. Note the audible noise behavior in the car and outside a car.

**4.3.6** Measure the thickness of all brake linings, rotors, and drums at the locations of the initial thickness measurements. See example reporting sheet for wear measurements in Appendix G, Figures G3 through G5.

**4.3.7** Measure the brake drag torque at 0 km, 2500 km, 5000 km, 7500 km, and 10 000 km. Do the measurement as follows:

- a. Drive the vehicle 1 km at slow speed without any brake application. Measure drag torque.
- b. Disengage the transmission, and apply the brake pedal to 6000 kPa three times in 6 s. Measure drag torque.
- c. Mark five wheel rotations. Measure drag torque.

Optional test: Place car on hoist (no wheel bearing load) and push back brake caliper linings. Measure drag to get caliper drag torque only.

**4.3.8** Observe the brake dust on the wheel rims every day of testing. Take photographs for evaluation after 2500 km, 5000 km and 10 000 km if the brake dust is visible.

**4.3.9** At 10 000 km, examine brake system for any leakage, brake hose or pipe witness rub marks, caliper operation, etc.

## 5 Data

### 5.1 Calculations.

**5.1.1** Calculate the minimum and maximum noise ratings and the average rating over the 10 000 km, unless otherwise instructed.

**5.1.2** Calculate the lining life within 2 mm safety margin.

**5.1.3** Calculate the rotor and drum maximum wear. Wear targets are 3 mm for ventilated; 2 mm for solid rotors; drums maximum 1.5 mm related to diameter.

**5.1.4** Drag torque caliper requirements: (valid for 4.3.7a only - without transmission and bearing)

- a. Front Axle  $\leq 3$  Nm
- b. Rear Axle  $\leq 2$  Nm (or for an axle not driven by engine)
- c. Car on a hoist - No bearing load. See Vehicle Subsystem Technical Specification if no other information is available.
- d. Measure the drag torque with pushed back linings to get the caliper drag torque only.
- e. See Appendix F, Figure F1 for an example graph for drag torque measurements.

**5.2 Interpretation of Results.** Compare test results to applicable technical specifications or Best Practices. Using the methods in this test standard, comparisons to the following measurements are suggested during the testing.

- a. Vented rotor wear: 3 mm maximum
- b. Solid rotor wear: 2 mm maximum
- c. Drum wear: 1.5 mm maximum
- d. Brake drag torque: 3 Nm maximum

**5.3 Test Documentation.** Publish test record in an engineering evaluation report stored in the GM Global Document Management System.

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## 6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

## 7 Notes

**7.1 Glossary.** Not applicable.

**7.2 Acronyms, Abbreviations, and Symbols.**

|             |                             |
|-------------|-----------------------------|
| <b>ABS</b>  | Antilock Brake System       |
| <b>GVWR</b> | Gross Vehicle Weight Rating |
| <b>NAO</b>  | Non-Asbestos Organic        |
| <b>PG</b>   | Proving Ground              |

## 8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Test to GMW15316

## 9 Release and Revisions

This standard was originated in April 2006. It was first approved by the Chassis Global Brake Subsystem Leadership Team in May 2006. It was first published in April 2007.

| Issue | Publication Date | Description (Organization)                                                                                                                                                               |
|-------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | APR 2007         | Initial publication.                                                                                                                                                                     |
| 2     | APR 2013         | Changes to 1.3; 4.3.1; 4.3.2; 5.1.4. Updated 1.2 and Modules I, II and III. All Appendices and Figures within the appendices have been updated. (Brake Global Subsystem Leadership Team) |

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## Appendix A

## MODULE I – Brake Wear Driving Route Outline

|   |                                                                                                                                           |                             |
|---|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
|   | 1. Start Opel Portal 45. Head south on Alzeyer Straße toward Rugbyring/B43                                                                | go 13 m<br>total 13 m       |
| ↩ | 2. Take the 1st left onto Rugbyring/B43                                                                                                   | go 650 m<br>total 700 m     |
| ↗ | 3. Take the 2nd right onto Darmstädter Straße/B519<br>Continue to follow B519<br>About 2 minutes                                          | go 1.3 km<br>total 2.0 km   |
| ↗ | 4. Merge onto A60 via the ramp to Frankfurt/Darmstadt<br>About 2 minutes                                                                  | go 3.2 km<br>total 5.3 km   |
| ↗ | 5. Take exit 30-Rüsselsheimer Dreieck to merge onto A67 toward Basel/Heidelberg/<br>Stuttgart/Darmstadt<br>About 10 minutes               | go 17.2 km<br>total 22.5 km |
|   | 6. Continue onto E35                                                                                                                      | go 1.0 km<br>total 23.4 km  |
|   | 7. Merge onto A5<br>About 3 minutes                                                                                                       | go 5.7 km<br>total 29.2 km  |
| ↗ | 8. Take exit 27-Darmstadt-Eberstadt to merge onto Karlsruher Straße/B3/B426 toward<br>Mühlthal Continue to follow B426<br>About 5 minutes | go 4.9 km<br>total 34.1 km  |
| ↗ | 9. Turn right onto Beerbacher Straße/L3098<br>Continue to follow L3098<br>About 2 minutes                                                 | go 1.1 km<br>total 35.2 km  |
|   | 10. Head southeast on Mühlstraße/L3098<br>Continue to follow L3098<br>About 6 minutes                                                     | go 5.6 km<br>total 40.8 km  |
| ↗ | 11. Turn right onto Erbacher Straße/L3098<br>Continue to follow L3098<br>About 5 minutes                                                  | go 3.4 km<br>total 44.2 km  |
| ↩ | 12. Turn left onto Jugenheimer Straße/L3101<br>About 1 minute                                                                             | go 290 m<br>total 44.5 km   |
|   | 13. Continue onto L3098<br>About 1 minute                                                                                                 | go 1.0 km<br>total 45.5 km  |
| ↩ | 14. Turn left onto Reichenbacher Straße/L3098<br>Continue to follow L3098<br>About 4 minutes                                              | go 3.3 km<br>total 47.8 km  |

Niederbeerbach

Oberbeerbach

Schmalbeerbach

Wurzelbach

Beetenkirchen

Reichenbach

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|   |                                                                                                                |                                |                            |
|---|----------------------------------------------------------------------------------------------------------------|--------------------------------|----------------------------|
| ↶ | 15. Turn left onto Nibelungenstraße/B47<br>About 1 minute                                                      |                                | go 400 m<br>total 48.2 km  |
|   | 16. Head east on Nibelungenstraße/B47 toward<br>About 3 minutes                                                | Lautern                        | go 3.9 km<br>total 52.1 km |
| ↷ | 17. Turn right onto Knodener Straße/ (Volksbank) /K210<br>About 2 minutes                                      | Gadernheim                     | go 1.3 km<br>total 53.4 km |
|   | 18. Head south on Raidelbacher Straße/K21                                                                      | Raidelbach                     | go 400 m<br>total 53.8 km  |
| ↷ | 19. Keep right at the fork onto Knoden<br>About 1 minute                                                       |                                | go 700 m<br>total 54.5 km  |
| ↷ | 20. Turn right onto Krehbergstraße/K55<br>Continue to follow K55<br>About 3 minutes                            | Knoden                         | go 2.2 km<br>total 56.7 km |
|   | 21. Head southeast on Knodener Straße/K55<br>Continue to follow K55<br>About 3 minutes                         | Seidenbuch                     | go 3.0 km<br>total 59.7 km |
|   | 22. Head northwest on K55 toward Ortsstraße                                                                    | Glattbach                      | go 700 m<br>total 60.4 km  |
| ↶ | 23. Turn left onto Ortsstraße/K55                                                                              | Winkel                         | go 91 m<br>total 60.5 km   |
| ↷ | 24. Take the 1st right onto Fürth /L3099<br>Continue to follow L3099<br>About 6 minutes                        | Schlierbach Eulsbach Ellenbach | go 5.4 km<br>total 65.9 km |
|   | 25. Head southeast on Ellenbacher Straße/L3099<br>About 1 minute                                               |                                | go 750 m<br>total 66.7 km  |
| ↷ | 26. Turn right onto Heppenheimer Straße/B38/B460                                                               | Fürth                          | go 280 m<br>total 66.9 km  |
| ↶ | 27. take the 2nd Jet petrol station on the left towards Fahrenbach<br>Continue to follow K24<br>About 1 minute | Fahrenbach                     | go 1.1 km<br>total 68.0 km |
|   | 28. Head southwest on Fahrenbacher Straße/K24 toward Waldstraße<br>About 2 minutes                             | Rimbach                        | go 1.6 km<br>total 69.6 km |
| ↷ | 29. Turn right onto Erikastraße/K24                                                                            |                                | go 120 m<br>total 69.8 km  |
|   | 30. Head northwest on Erikastraße/K24 toward Annastraße                                                        |                                | go 160 m<br>total 69.9 km  |
| ↶ | 31. Turn left onto Staatsstraße/B38<br>Continue to follow B38<br>About 3 minutes                               |                                | go 2.2 km<br>total 72.1 km |
|   | 32. Head southeast on B38                                                                                      |                                | go 230 m<br>total 72.3 km  |

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