



High Performance Brake Lining Wear Versus Temperature Inertia Dynamometer Test

1 Introduction

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. This procedure documents an inertia dynamometer test used to measure brake lining wear rates from 400 °C to 700 °C.

1.2 Applicability. This procedure is applicable to all high performance passenger car and light truck front and rear disc brake corners.

1.3 Remarks. This procedure is intended to quantify brake lining wear rate as a function of brake operating temperatures. Tapered lining wear is also evaluated as part of this test.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14974

GMW14986

GMW15142

2.3 Additional References.

- CG3856
- Global Document Management (GDM) System, (<https://documents.gm.com/gdm3/component/main>)
- Test Information Sheet

3 Resources

3.1 Facilities. Milford Proving Ground Brake Component Development inertia brake dynamometer or equivalent Test Improvement Process (TIP) accredited test dynamometer shall be used.

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.

3.2 Equipment.

3.2.1 An inertia brake dynamometer capable of performing torque control, ramp, and modulated brake applies.

3.2.2 The following measurements shall be made and digitally recorded at 500 Hz:

- Dynamometer speed (kilometers/hour)
- Brake apply pressure (kilopascals)
- Brake torque (Newton·meters)
- Brake rotor/drum temperature (degrees Celsius)
- Fluid displacement (cubic millimeters)

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3.3 Test Vehicle/Test Piece. Production representative brake corner hardware shall be used to produce the tailstock assembly.

3.4 Test Time.

Calendar time:	3 days
Test hours:	50 hours
Parts preparation time:	2 hours
Set up time	3 hours

3.5 Test Required Information. A Test Information Sheet needs to be completed by the test requester and submitted to the test engineer. Other facilities should require similar forms. Required information includes, at a minimum; brake corner inertia, rolling radius, effective radius, piston size and number, and pad area.

3.6 Personnel/Skills. One (1) technician trained for the operation of an inertia brake dynamometer and to perform the duties described in Section 4 is required.

4 Procedure

4.1 Preparation.

4.1.1 Embedded rotor thermocouple shall be installed per GMW14974.

4.1.2 The assembled corner Lateral Runout (LRO) shall not exceed 50 μm . The corner LRO shall be measured on the inboard face of the rotor at a radius 10 mm inside of the rotor outer diameter using a dial indicator and recorded.

4.2 Conditions.

4.2.1 Environmental Conditions. Cooling air is provided to the brake. Cooling air temperature shall be between 10 °C and 30 °C. Cooling air humidity control is not required.

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 The dynamometer inertia is adjusted per GMW15142.

4.3 Instructions.

4.3.1 Measure and record the start of test brake lining thickness and mass (GMW14986), as well as rotor thickness and mass. Take photographs of pad friction surface, and from each of four (4) edges of the pad.

4.3.2 Without preheating the brakes, perform five (5) green (new linings and rotor) warm ramp applies, and three (3) modulated applies.

4.3.3 Perform track brake burnish schedule.

4.3.4 Allow brake to cool to room temperature. Measure and record the post burnish brake lining thickness and mass (GMW14986). Take photographs of pad friction surface, and from each of four (4) edges of the pad.

4.3.5 Perform 50 snubs, from 180 km/h to 80 km/h, Initial Brake Temperature (IBT) of 400 °C, 7000 kPa/s apply rate to a torque controlled 0.8G deceleration, and 40 km/h cooling air speed once IBT has been reached.

4.3.6 Allow brake to cool to room temperature. Measure and record the brake lining thickness and mass (GMW14986), as well as rotor thickness. Take photographs of pad friction surface, and from each of four (4) edges of the pad.

4.3.7 Repeat 4.3.5 with an IBT of 450 °C, 500 °C, 550 °C, 600 °C, 650 °C, 700 °C, and back to 400 °C. Between each temperature iteration repeat 4.3.6. At end of test, rotor mass should also be recorded.

4.3.8 In the event that the lining thickness is not sufficient to complete subsequent temperature sections of the test, the linings may be replaced in order to complete the schedule. In this event, new linings should be measured per 4.3.1, installed, and burnished per 4.3.3. Following burnish, the test should resume immediately prior to the temperature section, where the test was left off with the first set of linings.

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Documents

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5 Data

5.1 Calculations.

5.1.1 Brake Lining Wear. Brake lining wear (millimeters) per 100 stops at each temperature increment shall be recorded (see Table A1, Appendix A) and plotted (see Figure A1, Appendix A).

5.1.2 Tapered Lining Wear vs. Temperature. Following GMW14986, measure and record tapered lining wear (see Figure A2, Appendix A).

5.1.3 Total Tapered Lining Wear. Following GMW14986, measure and record tapered lining wear (see Figure A3, Appendix A).

5.1.4 Brake Lining Mass Loss. Brake lining mass loss (grams) per 100 stops at each temperature increment shall be tabulated and plotted (see Appendix A, Figure A4). Measured mass loss shall be multiplied by two (2) to represent the mass loss per 100 stops.

5.1.5 Volumetric Wear. Brake lining volumetric wear (cubic millimeters/mega Joule) per 100 stops at each temperature increment shall be plotted (see Appendix A, Figure A5).

5.1.6 Average Apparent Friction. Average apparent friction shall be calculated for 1st stop and every 10th stop and plotted vs. stop number (see Appendix A, Figure A6) for each temperature increment.

5.1.7 Apparent Piston Travel. Average apparent piston travel shall be calculated for 1st stop and every 10th stop and plotted vs. stop number (see Appendix A, Figure A7) for each temperature increment.

5.2 Interpretation of Results. Results may be compared to the results for other lining materials, or to applicable requirements in technical specifications.

5.3 Test Documentation. Publish test information and results in an engineering report stored in Global Document Management (GDM) System.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary.

Energy per Stop: Amount of energy dissipated into the brake system by one braking event.

$$\text{Energy per stop} = 0.001 \times 0.5 \times \left\{ \left(\frac{\text{Initial Speed}}{3.6 \cdot \left(\frac{\text{SLR}}{1000} \right)} \right)^2 - \left[\frac{\text{Final Speed}}{3.6 \cdot \left(\frac{\text{SLR}}{1000} \right)} \right]^2 \right\} \times \text{Inertia}$$

Where:

Initial Speed in kilometers/hour (km/h)

Final Speed in kilometers/hour (km/h)

SLR = Static Loaded Radius in millimeters (mm)

Inertia in kilogram-meters squared (kg-m²)

Initial Brake Temperature (IBT): The brake rotor temperature at the start of the braking event.

Modulated Applies: Modulated applies are made from an IBT of 90 °C, 100 km/h initial speed, 30 km/h cooling air speed, and 0.5 Hz sinusoidal, or ramp apply and release at 6200 kPa/s, to 6200 kPa maximum pressure. Two (2) to three (3) pressure modulations are performed during one (1) modulation test. If less than two (2) modulations are performed prior to the dynamometer speed reaching zero (0), the maximum pressure may be reduced to a level which generates two (2) to three (3) modulations.

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