



Brake Pad to Rotor Stiction and Break-Away Force

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 is intended to document a laboratory based method to assess the brake pad to rotor stiction characteristics after exposure to a high humidity environment.

1.2 Applicability. This standard applies to all disc brake systems.

1.3 Remarks. Sample brake rotors and brake pad assemblies are preconditioned on a dynamometer, soaked in solution and then exposed to a high humidity environment followed by ambient dry off exposures. The humidity and ambient stages are repeated for a total of three (3) cycles. The amount of force required to break the pad free from the rotor is then measured at the end of the test and compared to brake corner requirements.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14729	GMW14925	GMW15142	GMW15392
GMW14872	GMW14933		

2.3 Additional References.

Evaluation Report Template

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 Test laboratory with a humidity chamber capable of performing the humidity exposure, as specified in GMW14729 and ambient dry off sections in GMW14872.

3.1.4 Brake laboratory with inertia dynamometer capable of performing the controlled brake applications as listed in this specification.

3.1.5 Laboratory capable of performing pad break-away force measurements per 4.3.3 of this specification.

3.2 Equipment.

3.2.1 Dynamometer data acquisition system capable of recording the following channels, per GMW14925:

3.2.1.1 Dynamometer speed (kilometers/hour).

3.2.1.2 Brake apply pressure (kilopascals).

3.2.1.3 Brake torque (Newton-meters).

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3.2.1.4 Brake rotor temperature (degrees Celsius).

3.2.1.5 Fluid displacement (cubic millimeters).

3.2.2 Humidity chamber rack designed to hold six (6) rotors, calipers and pad sets in vehicle position.

3.2.2.1 Six (6) brake hoses and shut off ball valves to hold hydraulic pressure during exposures.

3.2.2.2 Bench brake apply system to pressurize the calipers and clamp the pads to the rotor.

3.2.3 Test rig with actuator and load cell or similar, to measure pad to rotor break-away force.

3.2.3.1 Liner load actuator capable of an apply rate of 10 mm/minute or slower.

3.2.3.2 Fixture to retain the rotor and pad assembly in place during break-away force measurement.

3.2.3.3 Push rod fixture to load pad on the backplate abutment in the braking direction.

3.2.3.4 Data acquisition system capable of recording break-away force and travel at 100 Hz or faster.

3.3 Test Vehicle/Test Piece. One (1) set of pads will be required per rotor sample. If the test is conducted for the purpose of validation, a minimum of six (6) samples shall be tested. The number of development samples and requirements are defined in GMW15392.

3.4 Test Time.

Calendar time: 7 days to 10 days

Test time: 48 hours

Coordination time: 4 hours

3.5 Test Required Information. Obtain the necessary vehicle parameters to calculate the brake dynamometer settings per GMW15142. Caliper piston size(s) are needed for calculation of the brake pressure to pad clamp force relationship.

3.6 Personnel/Skills. One (1) technician trained in the operation of the inertia dynamometer and capable of performing the tasks listed in Section 4 of this document. One (1) technician skilled in the operation of the humidity chamber.

4 Procedure

4.1 Preparation.

4.1.1 If the pad assembly uses double sticky tape between the caliper and backplate, remove this prior to dynamometer preconditioning to prevent the pad assembly from sticking to the caliper fingers or piston face during testing.

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.

4.2.3 During dynamometer inertia preconditioning, the Assembled Lateral Run-Out (ALRO) of the brake corner shall not exceed 50 μ m when measured on the inboard rotor cheek at a position 10 mm from the outer diameter of the rotor, per GMW14933. This measurement is only performed in the beginning of the dynamometer preconditioning (e.g., once per rotor at start of test).

4.2.4 The dynamometer inertia parameters shall be set as described in GMW15142 except using Lightly Loaded Vehicle Weight (LLVW) rather than Gross Vehicle Weight (GVW).

4.3 Instructions.

Note: Appendix A, Figure A3 defines a process flow for the test samples through the various test sections.

4.3.1 Brake Pad and Rotor Preconditioning.

4.3.1.1 Label each rotor and lining sample pair with a unique identifier.

4.3.1.2 Install the brake corner assembly to the inertia dynamometer per 4.2.3. Perform ten (10) braking snubs as described in Appendix A, Table A1. For all other dynamometer instructions, refer to the burnish section of GMW14925.

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4.3.1.3 Publish dynamometer settings used as shown in Appendix A, Figure A1.

4.3.1.4 Remove the rotor, caliper and brake pad in preparation for the humidity test cycles.

4.3.2 Brake Pad to Rotor Humidity and Ambient Cycling.

4.3.2.1 Insure that each rotor and brake pad sample identification will not be damaged during the humidity exposure by using an appropriate protection or marking method. Example methods include paint pen marking covered with tape or etching the rotor hat and backplate.

4.3.2.2 For Motor On Caliper (MOC) and other electric or integral park brake caliper applications, a 5000 N caliper clamp force is used to hold the brake pads onto the rotor. For calipers without parking brake features, a 100 N clamp force is used. This clamp force is created by using the hydraulic brake line pressure, as specified by the requestor. To calculate the hydraulic brake pressure to achieve target clamp force, use the following equations.

$$\text{Hydraulic Brake Pressure (P)} = \frac{\text{Piston Force (F)}}{\text{Effective Piston Area (A}_p\text{)}}$$

$$\text{Effective Piston Area (A}_p\text{)} = \pi(D/2)^2$$

Where:

F = Piston Force

A_p = Effective Piston Area

P = Hydraulic Pressure

D = Piston Diameter

Example: Using the above equations, a single piston 38 mm caliper would need 44 bar hydraulic brake pressure to create 5000 N clamping force.

4.3.2.3 Per GMW14872, soak the brake pads in a container of 1% salt and water solution for 15 minutes.

4.3.2.4 Align the caliper and pad assembly on the rotor in the installed car position without the carrier bracket and apply brake line pressure as specified by the requestor to clamp the brake pads onto the brake rotor. Close the ball valve to allow the caliper to hold brake line pressure. See Appendix A, Figures A4 and A5. Mark the rotor hat to later identify the first pad clamp location.

4.3.2.5 Set the apply system to zero brake pressure and separate the brake line between the apply system and the ball valve thereby leaving the caliper still pressured and clamping the pad to the rotor. A hydraulic quick connect aids in the removal of the brake assembly from the apply system.

4.3.2.6 Mount the pressured caliper, pads and rotor assembly onto the humidity chamber rack in vehicle orientation (clocking angle within ± 20 degrees). See Appendix A, Figures A6 and A7.

4.3.2.7 Expose the rotor and caliper assembly to three (3) test cycles as specified in Appendix A, Table A2. Reference Appendix A, Table A3 for an example.

4.3.2.8 Carefully remove the parts from the humidity chamber in preparation for the pad break-away measurement. Take photographs of the test samples. Do not disrupt the pad to rotor adhesion. Keep the caliper, rotor, and pad clamped together in place until the parts are moved to the break-away measurement device.

4.3.3 Brake Pad to Rotor Break-Away Force Measurement.

4.3.3.1 Within 24 h of completing humidity cycles the pad break-away force is to be measured.

4.3.3.2 Just prior to the pad break-away measurement, use the brake apply system to release the hydraulic pressure from the caliper. Carefully remove the caliper while leaving the pads stuck to the rotor plates.

4.3.3.3 Mount the brake rotor and pad set to the break-away test fixture, as shown in Appendix A, Figures A8, A9 and A10.

4.3.3.4 Independently load each brake pad by pushing on the pad backing plate edge in the location that the pad would contact the caliper carrier bracket simulating a brake stop. Use a load rate of 10 mm/minute or slower. See Appendix A, Figures A9 and A10 for loading fixture description.

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4.3.3.5 Record the maximum pad break-away force of each pad sample. See Appendix A, Table A4 and Figure A2 for example data summaries.

4.3.3.6 Photograph the rotor and pad braking surface of each sample after performing the pad break-away measurement. Document any irregularities (e.g., crumbled or broken friction material). See Appendix A, Figures A11 and A12 for examples of a posttest sample.

4.3.3.7 Using the same hardware, perform GMW14925 Brake Corner Performance Inertia Dynamometer test Appendices titled:

- Instruction for Test – Start of Test thru 4.3.10.
- Instruction for Test – 4.3.11 thru End of Base Park Brake Test (excluding Start of Base Park Brake Test section).
- Instruction for Test – 4.3.21 thru End of Test.

4.3.3.8 Take photographs of the test samples.

4.3.3.9 Measure and document the average surface roughness of the inboard and outboard brake plates of each rotor. Each rotor plate shall be measured at six (6) equally spaced locations in a tangential measuring direction and a random radial position. Each measurement shall be 15 mm in length with a 2.5 mm cutoff length and a 12.5 mm evaluation length. See Appendix A, Figure A13 for a detailed description of the roughness measurements.

4.3.3.10 Repeat sections 4.3.2.1 through 4.3.3.9 of GMW16696. Note that clamp location of pads on the rotor brake plate in the second cycle shall not overlap the location from the first cycle.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Refer to GMW15392 (Front and Rear Brake Corner Technical Specification) for brake pad break-away requirements. Include requirements in the tabular data summaries.

5.2.1 Graphical Summaries.

5.2.1.1 Pad Break-Away Force. Graph the break-away force vs. displacement for each sample if this information is available from the test equipment. See Appendix A, Figure A2.

5.2.2 Tabular Summaries.

5.2.2.1 Break-Away Force. Create a table that includes the maximum force recorded to break each pad away from the rotor surface. See Appendix A, Table A4 for an example data table.

5.3 Test Documentation. Publish test sample information, dynamometer settings, sample photographs, and test results according to GM company protocol using the Evaluation Report template and Global Document Management (GDM) System or its successor.

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.

Corrected-Pressure Control: A dynamometer control method that determines the average deceleration rate during a constant pressure brake application and adjusts the target pressure of the following brake application to achieve the desired deceleration rate.

Initial Brake Temperature: The brake rotor temperature at the start of a braking event.

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7.2 Acronyms, Abbreviations, and Symbols.

@	at
ALRO	Assembled Lateral Run-Out
CG	Center of Gravity
Dyno	Dynamometer
GDM	Global Document Management
GSSLT	Global Subsystem Leadership Team
GVM	Gross Vehicle Mass
GVW	Gross Vehicle Weight
I/B	Inboard
LLVW	Lightly Loaded Vehicle Weight
LVW	Light Vehicle Weight
MOC	Motor On Caliper

8 Coding System

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

Test to GMW16696

9 Release and Revisions

This standard was originated in September 2011. It was first approved by Chassis Brake Global Subsystem Leadership Team in March 2012. It was first published in March 2012.

Issue	Publication Date	Description (Organization)
1	MAR 2012	Initial publication.
2	OCT 2013	Updated standard to new test condition created from DFSS project. (Chassis Brakes Global Subsystem Leadership Team)
3	MAR 2016	Updated Section 4. (Chassis Brake Global Subsystem Leadership Team (GSSLT))
4	DEC 2017	Updated clamp force requirements to separate park brake and non-park brake targets. Eliminated provision to remove rotor coating prior to test. Moved surface roughness measurements to post breakaway sections. (Chassis Brake GSSLT)

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