



Inertia Dynamometer Cyclical Rotor Corrosion Cleanability

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 standard documents a laboratory-based method used to assess the effects of corrosion exposure on brake corner dynamic performance. It addresses common corrosion induced performance issues resulting from single and repeated corrosion exposures.

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

1.3 Remarks. This standard is intended to assess two (2) performance characteristics of the brake corner after being exposed to a highly corrosive ambient environment.

1.3.1 Apparent Friction with Corrosion. Sample brake rotors are exposed to a corrosive environment and then installed on the dynamometer. Two hundred (200) burnish stops are conducted during which the apparent friction of the lining is assessed for its ability to recover to 90% of the pre-corrosion condition.

1.3.2 Rotor Cyclical Corrosion Cleanability. Sample brake rotors are exposed to a corrosive environment and then installed on the dynamometer. Twenty-five (25) burnish stops are conducted after which the rotors are returned to the corrosion laboratory. The cycle is repeated an additional three (3) times in an attempt to simulate the corrosion matter buildup that is observed in the field. Following the fourth cycle, the surface roughness of the rotors is assessed and compared to a target value per GMW15392. Rotor Cyclical Corrosion is not applicable to low-metallic friction materials.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14872	GMW14933	GMW14985	GMW15392
GMW14925	GMW14974	GMW15142	

2.3 Additional References.

CG190 (ID)

Global Document Management (GDM) system (<https://documents.gm.com/gdm3/component/main>) (ID)

(ID) = This reference is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

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.

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Note: Alternative test facilities and equipment must obtain an official GM Test Improvement Process (TIP) accreditation prior to submitting test data to GM.

3.1.3 Corrosion laboratory capable of performing the procedure specified in GMW14872.

3.1.4 Inertia brake dynamometer capable of performing corrected-pressure controlled brake applications and TIP certified for GMW14925.

3.2 Equipment.

3.2.1 Surface roughness gage with a skid-less type stylus with a 10 µm or less radius.

3.2.2 Data acquisition system capable of recording the channels (3.2.2.1 through 3.2.2.5) at 500 Hz:

3.2.2.1 Dynamometer speed (kilometers/hour).

3.2.2.2 Brake apply pressure (kilopascals).

3.2.2.3 Brake torque (Newton-meters).

3.2.2.4 Brake rotor temperature (degrees Celsius).

3.2.2.5 Fluid displacement (cubic millimeters).

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 three (3) rotor samples shall be tested. Number of samples and requirements to be met are defined in GMW15392.

3.4 Test Time.

Calendar time: 25 days to 45 days

Test time: 325 hours

Coordination time: 7 hours to 10 hours

3.5 Test Required Information. Not applicable.

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 Procedure.

4 Procedure

4.1 Preparation. Rotors shall have an embedded thermocouple installed according to the method specified in GMW14974.

4.2 Conditions.

4.2.1 Environmental Conditions. The cooling air temperature shall be between 10 °C and 30 °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 The Assembled Lateral Run-Out (ALRO) of the brake corner shall not exceed 50 µm 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 pre-corrosion state (e.g., once per rotor).

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

4.2.2.3 For vehicles that use regenerative braking systems, the dynamometer inertia shall be set according to 4.2.2.2 for the 200 burnish stop (4.3.1.2, 4.3.1.6, and 4.3.3.1) and set to the regenerative braking inertia level for the 25 burnish stop (4.3.2.3). Obtain the regenerative braking inertia level via vehicle information and GMW15142.

4.3 Instructions.

Note: Appendix A, Figure A1 defines a process flow for the sample parts through the various test sections.

Note: Record data per 3.2.2 during all stops on the dynamometer.

4.3.1 Apparent Friction with Corrosion.

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

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4.3.1.2 Install the brake corner assembly to the inertia dynamometer per 4.2.2.1. Perform 200 burnish stops as described in Appendix A, Table A1.

4.3.1.3 Prepare each sample for the corrosion laboratory. Insure that the sample identifier will not be damaged during the corrosion sequence. Cover the wheel and bearing mounting surfaces of the rotor with tape to prevent corrosion exposure.

4.3.1.4 Apply tape to the rotor cheeks covering the area where the pad contacts the rotor.

4.3.1.5 Expose the rotor to two (2) cycles of the corrosion procedure specified in GMW14872. During corrosion exposure, mount the rotor in the vehicle position with the rotor vertical and the tape representing the pads in the proper vehicle orientation (within ± 20 degrees).

4.3.1.6 After two cycles of corrosion remove all tape. Install the brake corner assembly to the inertia dynamometer. Perform 200 burnish stops as described in Appendix A, Table A1. If testing low-metallic friction materials, testing is now complete. If testing Non-Asbestos Organic (NAO) friction materials, continue to 4.3.2.

4.3.2 Rotor Cyclical Corrosion Cleanability.

4.3.2.1 Prepare each rotor sample for the corrosion laboratory. Ensure that the sample identifier will not be damaged during the corrosion sequence. Cover the wheel and bearing mounting surfaces of the rotor with tape to prevent corrosion exposure. Do not cover the rotor cheeks where the pad contacts the cheek.

4.3.2.2 Expose the rotors to two (2) cycles of the corrosion procedure specified in GMW14872. During corrosion exposure, mount the rotor in the vehicle position with the rotor vertical.

4.3.2.3 After two cycles of corrosion remove all tape. Install the brake corner assembly to the inertia dynamometer using the rotor and pads from 4.3.1. Perform 25 burnish stops as described in Appendix A, Table A1.

4.3.2.4 Photograph the inboard and outboard rotor cheeks of each sample following the 25 stop burnish.

4.3.2.5 Repeat 4.3.2.1 through 4.3.2.4 an additional three (3) times for a total of four (4).

4.3.2.6 Within 24 h of the end of the final 25 burnish stops, measure and document the Average Surface Roughness (Ra) of the inboard and outboard cheeks of the rotor. Each cheek shall be measured at six (6) equally spaced locations with a tangential measuring direction and a random radial position. Each measurement shall be 15 mm in length with a 2.5 mm cutoff length (12.5 mm evaluation length). See Appendix A, Figure A2, for a detailed description of the measurements.

4.3.2.7 Store the rotors between 15 °C and 20 °C and 40% to 60% relative humidity for five (5) days in an orientation such that the rotor cheeks do not contact any other object.

4.3.2.8 Record the post-five (5) day soaking period average surface roughness of the rotor cheeks following the method used in 4.3.2.6.

4.3.2.9 Photograph the inboard and outboard rotor cheeks of each sample.

5 Data

5.1 Calculations.

5.1.1 Corrosion Cleanability.

5.1.1.1 Calculate the Apparent Friction (AF) and maximum peak-to-peak (p-p) Brake Torque Variation (BTV) in Newton-meters and percentage at each of the 200 stops in the pre-corrosion and post-corrosion conditions. Refer to GMW14985 for details about calculating p-p BTV.

Apparent Friction:

$$AF = \frac{\left(\frac{T}{2 * r_e} \right)}{P * A_p}$$

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Where:**AF** = Apparent friction**A_p** = Effective piston area**P** = Hydraulic pressure**T** = Braking torque**r_e** = Effective radius

5.1.1.2 Calculate the number of stops in the post-corrosion conditions that were necessary to achieve an apparent friction value greater than or equal to ninety percent (90%) of the average apparent friction of the last fifty (50) stops of the pre-corrosion condition.

5.1.1.3 Calculate the percent recovery of the 90% of the average apparent friction value from 5.1.1.2 at 25 stops.

5.1.1.4 Filter the surface roughness data using a Gaussian filter.

5.1.2 Cyclical Corrosion Cleanability. Calculate the apparent friction and brake torque variation at each of the 25 stops of the post-corrosion burnish sequences.

5.2 Interpretation of Results. Refer to GMW15392 for brake corner performance requirements. Record requirements in the proper location for graphical and tabular summaries.

5.2.1 Graphical Summaries.

5.2.1.1 Average Surface Roughness. Graph the average surface roughness of each rotor cheek of each rotor at the end of the fourth cycle and after the five (5) day soaking period. See an example graph in Appendix A, Figure A3.

Note: Two (2) graphs are required: One (1) for end of the fourth cycle measurement (4.3.2.6) and another for post 5 day soaking period (4.3.2.8).

5.2.1.2 Apparent Friction and Brake Torque Variation.

5.2.1.2.1 Graph the apparent friction and brake torque variation for every fifth stop of the 200 stops for the pre-corrosion and post-corrosion conditions. See example graphs in Appendix A, Figures A4 through A6.

5.2.1.2.2 Graph the apparent friction and brake torque variation for the four (4) 25 stop burnish sequences. See example graphs in Appendix A, Figures A7 through A9.

5.2.2 Tabular Summaries.

5.2.2.1 Ninety Percent (90%) of Average Apparent Friction. Create a table listing sample identification, lining type, and number of stops necessary to achieve an apparent friction value greater than or equal to 90% of the average apparent friction of the last 50 stops of the pre-corrosion condition calculated in 5.1.1 for the post-corrosion 200 stop burnish conditions and the percent recovery at 25 stops. See example tables in Appendix A, Table A2 and A3.

5.3 Test Documentation. Publish test information, photographs, and results according to GM company protocol using the Evaluation Report Template (CG190) 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.

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