GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW16311

Wheel Bearing Spalling Ballasted Passenger Vehicle

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 describes the laboratory procedure for testing wheel bearing spalling to validate the long term reliability/durability of wheel bearings used on General Motors ballasted passenger vehicles. Wheel bearing suppliers are required to implement their own written procedure that is consistent with, and correlated to, this description.

1.2 Applicability. This standard is applicable for tests performed during product development, Design Validation (DV) and Product Validation (PV), for wheel bearings to be used on General Motors vehicles.

1.3 Remarks. This standard includes a general description of the laboratory test procedure for evaluating spalling of passenger vehicle wheel bearings. Associated measurements, inspections, analyses and monitoring procedures are also given.

The applicable Wheel Bearing Statement of Requirements (SOR) or Component Technical Specification (CTS), provides program-specific information and acceptance criteria for bearings tested according to this standard. In the event there is disagreement between this standard and the SOR or CTS, the SOR or CTS has precedence.

2 References

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

2.1 External Standards/Specifications.

SAE J2562

2.2 GM Standards/Specifications.

GMW15760

2.3 Additional References.

SAE Paper 2004-01-1578, Development of the SAE Biaxial Wheel Test Load File

Wheel Bearing Component Technical Specification (CTS)

Wheel Bearing Statement of Requirements (SOR)

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.

3.1.2.1 Test facilities must be certified per the GM Test Improvement Process (TIP).

3.2 Equipment. The test equipment shall be capable of accurately applying the environmental and loading conditions described in this standard. The equipment must be able to apply these inputs at vehicle-specific levels (forces, etc.) and frequencies specified separately by GM for each vehicle program or wheel bearing family. All measurement equipment must be capable of accurately making the measurements specified.

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3.3 Test Vehicle/Test Piece.

3.3.1 Parts are specified in this standard for two types of purposes:

a. For determining the reliability/durability of the bearings when exposed to specified customer usage and environmental factors.

b. For additional new (unexposed) parts to be measured or analyzed, in some cases destructively, rather than being exposed to the durability test conditions.

Measurements and analyses on these unexposed bearings are used for comparison with parts that have undergone the durability testing. The purpose of these comparisons is to assess potential degradation and/or causes of failure. The additional unexposed parts (henceforth referred to as comparison parts), should be selected from the same sources/batches as the durability test parts.

3.3.2 The spalling tests should be performed on new parts. New parts will be required for destructive testing on unexposed parts.

3.3.3 Test parts used for DV are to be from production tooling and processes to the extent possible. PV requires parts to be from production tooling and processes unless an exception is approved in writing by the General Motors contact specified in the SOR document.

3.3.4 Selection of parts undergoing PV shall be made according to GMW15760 Multi-Vari Sample Selection Procedure for Product Validation.

3.3.5 The part selection concepts in GMW15760 should also be applied, if possible, during the assembly of components for DV. Factors to consider for DV parts include minimum and maximum preload parts, minimum and maximum Constant Velocity Joint (CVJ) nut torque, and where applicable, parts tested with and without CVJs.

3.3.6 Within each phase (DV and PV), the number of test parts for each test shall be at least eight (8). During PV, the sample sizes shall be the larger of eight (8) or two (2) bearings from each shift (produced a minimum of 3 h apart) on each wheel bearing assembly line (from all assembly facilities). Critical parts (balls or rollers, races, seals, grease, etc.) should come from as many of the planned or actual production sources (suppliers, production lines, shifts, etc.) as possible.

3.4 Test Time.

Calendar time:	8 days (per bearing)
Test hours:	140 hours (per bearing)
Coordination hours:	48 hours (per bearing)

3.5 Test Required Information.

3.5.1 The supplier is required to have written local procedures consistent with the procedure description in 4.3 of this standard.

3.5.2 There are three main categories of procedures listed in this standard.

a. Reliability/durability tests, which are simulations of customer usage and environmental exposure.

b. Reliability/durability test monitoring procedures, used to non-destructively determine the condition of the bearings during the course of the reliability/durability testing.

c. Inspections, measurements and analyses used to determine the properties and/or condition of new and/or tested bearings.

3.6 Personnel/Skills. Personnel performing the testing and measurements to validate parts for GM shall be trained by the supplier.

4 Procedure

4.1 Preparation. Not applicable.

4.2 Conditions.

4.2.1 Environmental Conditions. Applicable conditions are specified in 4.3.

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.

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4.3 Instructions.

4.3.1 Spalling Test.

4.3.1.1 The spalling test is intended to check for design deficiencies related to long term load-carrying capability. This includes material selection, heat treatment, section thicknesses, ball or roller and raceway size and spacing, lubrication, assembly retention, and retention/alignment of components such as seals and sensor rings.

4.3.1.2 The spalling test includes a schedule of varying lateral and radial loads that are based on measured customer usage. Cornering and rough road driving are emphasized.

4.3.1.3 For reference, the original basis for these loads is SAE J2562, Biaxial Wheel Fatigue Test and SAE Paper 2004-01-1578, Development of the SAE Biaxial Wheel Test Load File. Changes applied to the wheel test loading, made to facilitate wheel bearing testing, were:

a. The number of unique load conditions and number of wheel revolutions have been dramatically reduced, based on wheel bearing life analyses.

b. The loads are changed less frequently.

c. The loads are ordered to reduce the amount of load change at each step (rather than using a random order).

d. Multiple rotational speeds are allowed, but not mandated.

4.3.1.4 Appendix B (Section B1, Figure B1) gives the step sequence and normalized loads for ballasted passenger vehicles. Scale the baseline by the vehicle corner weight as indicated. General Motors will supply the weights needed for this scaling for each vehicle program or wheel bearing family.

Note: If a wheel bearing is to be used on vehicles subject to more than one baseline load sequence (e.g., ballasted passenger vehicle and open-bed vehicle; or ballasted passenger vehicle and Nurburgring), the wheel bearing must be capable of meeting the reliability requirements for each applicable sequence.

4.3.1.5 The bearings are to be tested at normal room temperature. Except as allowed by the Wheel Bearing CTS or similar agreement, no direct cooling of the wheel bearing is allowed. Any cooling used is to be done with room temperature air, and is to be used only as needed to prevent the wheel bearing from exceeding the specified temperature. Fan operation should be regulated by wheel bearing temperature, rather than run continuously.

4.3.1.6 The wheel bearing should be tested at a rotational speed equivalent to between 112 km/h to 120 km/h vehicle speed. If necessary, lower speeds may be used for the higher loads. In following the time history load sequence, the time to transition between any two loads shall not exceed 5 s.

4.3.1.7 The entire time history sequence is repeated to wheel bearing failure or until a specified amount of testing has occurred without failure. Refer to the Wheel Bearing CTS for the allowable test suspension point.

4.3.1.8 Wheel bearing lives should be reported as repetitions of the schedule, not in test hours, as the test hours per repetition vary for each vehicle type and tire radius.

4.3.1.9 If the bearing includes a wheel speed sensor, continuous monitoring of its output is required. All sensor faults are to be noted in the test report, but the test is to continue despite any such faults. Vibration monitoring of wheel bearing condition, as described in 4.3.2.2 is to be performed continuously.

4.3.1.10 Definitions of failure, such as the amount of increased vibration, will be given in the Wheel Bearing CTS.

Note: Wheel bearing vibration failure criteria is to catch the early stages of wheel bearing fatigue on the raceways, balls or rollers. Expected shutdown criteria should be around 2x maximum vibration seen at start of test. Two-parameter Weibull analysis of the time to failure is to be used for comparison with the reliability requirements in the Wheel Bearing CTS. See 5.1 for guidelines on the Weibull analysis.

4.3.1.11 Teardown and inspection of all wheel bearings shall be performed following this test, with all evidence of damage, including spalling, wear, and grease degradation, to be recorded.

4.3.2 Test Monitoring Procedures. The conditions listed in 4.3.2.1 through 4.3.2.3 are to be monitored while conducting the spalling test.

4.3.2.1 Wheel Speed Sensor Signal. Any wheel bearing with a wheel speed sensor is required to have its output signal continuously monitored for proper operation during the test. All anomalies, including loss or degradation of signal (either permanent or intermittent), and inaccurate indicated speed, are to be investigated. Any fault caused by the wheel bearing speed sensor and/or its associated wiring is a non-conformance.

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