



Wheel Bearing Mud/Salt Water Splash

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. This standard describes a laboratory procedure used for testing sealing of wheel bearings during mud and salt water exposure to validate the long-term reliability/durability of wheel bearings used on General Motors passenger vehicles. Wheel bearing suppliers are required to implement their own written procedures that are consistent with, and correlated to, these descriptions.

1.2 Foreword. This standard includes general descriptions of laboratory test procedures for evaluating sealing during mud and salt water exposure 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), such as GMW15400, 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.

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

2 References

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

2.1 External Standards/Specifications.

ISO 12103-1

2.2 GM Standards/Specifications.

GMW15400

GMW15760

2.3 Additional References.

P/N 07-SKU-451518 Hubbard Supply

P/N 07-SKU-517048 Hubbard Supply

Fisher Scientific Catalog No. C70-500

Fisher Scientific at web site <http://www.fishersci.com>

Hubbard Supply Company at web site <http://sales@hubbardsupply.com>

McMaster-Carr at web site <http://www.mcmaster.com>

Powder Technology Incorporated at web site <http://contaminants@powdertechinc.com>

Component Technical Specification

Statement of Requirements

Best Practice - The supplier shall work with the GM responsible engineer to comprehend this requirement.

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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.

3.2 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.

3.3 Test Vehicle/Test Piece.

3.3.1 Parts are specified in this standard for two types of purposes: (1) for determining the reliability/durability of the bearings when exposed to specified customer usage and environmental factors, and (2) 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 sealing tests during mud and salt water exposure should be performed on new sets of 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.

3.3.6 Within each phase (DV and PV), the number of test parts for each test shall be at least six (6). During PV, the sample sizes shall be the larger of six or two 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:	30 days per bearing
Test hours:	650 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 document.

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; and (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.

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4 Procedure

4.1 Preparation. Build appropriate fixtures for mounting the test wheel bearings in the equipment. Refer to 4.2.2 for fixture and bearing mount requirements.

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.

4.2.2.1 For bearings where supplier plans to use the same design for driven and non-driven applications, supplier to run test without constant velocity joint (half-shaft).

4.2.2.2 This test is used to assess seal wear, water intrusion and corrosion inside and outside the wheel bearing. This test should be conducted without brake parts, splash shields, or other barriers to water or contaminant entry. However, if such parts are included in the test setup (for example, because they are needed for fixturing the parts), they may not limit the exposure of the seal(s).

4.3 Instructions.

4.3.1 Pre-Test Sensor Wire/Cable Pull. Prior to beginning this test, each wheel bearing design that includes wheel speed sensors of any type shall have a static pre-test 2G wire/cable pull of at least 10 s duration. This may be accomplished by adding weight to the wheel bearing equal to the wheel bearing's own weight, and slowly lifting the wheel bearing and added weight by the wire or cable. The additional weight should be placed such that the wheel bearing will hang at approximately the same orientation as it would without the added weight.

4.3.2 Slurry. Use water, salts and solids in the following proportions. See Appendix B, Table B1 for possible sources and minimum specifications of the slurry ingredients.

a. 3.8 L salt water solution consisting of:

- 3636 g distilled or deionized water
- 122.6 g sodium chloride
- 18.1 g calcium chloride dehydrate ($\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$), or 13.6 g anhydrous calcium chloride (CaCl_2)
- 10.2 g sodium bicarbonate

b. Plus solids consisting of:

- 400 g coarse dust (ISO 12103-1, A4)

4.3.2.1 The wheel bearing should be in a sealed enclosure to reduce the rate at which the slurry water evaporates. Replenish water only (not salts or other solids) as needed due to evaporation.

4.3.2.2 The test chamber design should minimize the accumulation of solids. Solid material that has accumulated on the bottom of the chamber is to be returned to the solution each working day.

4.3.2.3 Entire mixture is to be replaced with new mixture by 1000 h of wheel bearing rotation time.

4.3.3 Mud/Salt Water Splash Test.

4.3.3.1 Testing is done at room temperature, although the wheel bearing temperature will fluctuate due to its operation and the periodic splash applications. No cooling is allowed.

4.3.3.2 The test uses a repeating 24 h schedule. In general, the speed and splash conditions change hourly. See Figure A1.

4.3.3.3 The test can begin with a 97 km/h block, to provide a 1 h break-in period before being exposed to the splash, but this should not be used in the running hours calculation.

4.3.3.4 Only the actual rotating hours are counted toward time to failure. This is 20 h per full day. Scheduled off-time (4 h/day) and any unscheduled down time are not included.

4.3.3.5 Loading.

4.3.3.5.1 The radial load is constant throughout all parts of the test, rotating and non-rotating sections. Radial Load = $\frac{1}{2}$ of Gross Axle Weight Rating (GAWR). Radial load is applied at the center of tire tread.

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4.3.3.5.2 During rotational periods, the lateral load varies from zero to inboard to zero to outboard, then repeating. For half of the rotating time, the lateral load is zero. During non-rotating periods, the lateral load is zero.

4.3.3.5.2.1 Outboard lateral load equals radial load multiplied by 0.2. Outboard lateral load is applied at the tire patch. Outboard load will be applied $\frac{1}{4}$ of the rotating time.

4.3.3.5.2.2 Inboard lateral load equals radial load multiplied by 0.3. Inboard lateral load is applied at the tire patch. Inboard load will be applied $\frac{1}{4}$ of the rotating time.

4.3.3.5.3 During rotational periods, the lateral load is to change every 1 minute. The maximum allowable transition time between loads is 5 s. See bottom portion of Figure A1 for time histories of lateral loads.

4.3.3.6 Slurry Application.

4.3.3.6.1 The slurry is to be continuously stirred or re-circulated in a manner that keeps the solids in solution during the periods when it is being applied.

4.3.3.6.2 Inboard and outboard seals are to be tested separately unless agreements with the validation team and release community agree that both can be tested at the same time

4.3.3.6.3 Slurry is to be applied in a manner that completely floods, at low pressure and velocity, the entire circumference of all seals, as well as all other potential leak paths, such as on-bearing speed sensor connections. Flooding means that the surface is entirely covered with a thick layer of slurry that is being constantly replenished. The recommended nozzle positions should be at the 11 o'clock and 1 o'clock position on most bearings with the slurry hitting the knuckle or plate just above the bearing face for the inboard side. For the outboard (OB) side the nozzles are to be at approximately at the 11 o'clock and 1 o'clock positions where the slurry hits the barrel of the bearing pushing the slurry out into the gap between the spindle and outer ring. The gap should be fully submerged.

4.3.3.6.4 Slurry flow at each seal or end cap is to be applied using tubing, hoses, or nozzles with a total flow area of at least 2.52 cm². The recommended method is to use two 1.27 cm inside diameter nozzles per seal aimed at the top left and top right of the seal area. See Figure A2 and Figure A3 for example setups. Total slurry flow per seal is to be at least 7.2 L/minute.

4.3.3.7 Test Completion.

4.3.3.7.1 Criteria for test shutdown shall be provided by GM. If equipped with a wheel speed sensor, continuous monitoring of the signal is required for fault detection. The test should be shut down as soon as possible after a fault, so that a root cause can be determined. Vibration monitoring of wheel bearing condition, as described in 4.3.4.2, is to be performed whenever the wheel bearing is rotating. Temperature monitoring is required and criteria for shutdown due to temperatures shall be provided.

4.3.3.7.2 Failure criteria will be given in the Wheel Bearing CTS. Two-parameter Weibull analysis of the rotating hours to failure is to be used for comparison with the reliability requirements in the Wheel Bearing CTS.

4.3.3.7.3 Teardown and inspection of all bearings shall be performed following this test, with all evidence of damage, including water intrusion and corrosion, to be recorded and documented with photographs. Primary and secondary water intrusion paths (those which were primary contributors to failure, and all other paths, respectively) are to be identified. Seal and slinger wear must be documented as part of the teardown inspection. Photographs and cross sections to detail the wear must be provided. The seal wear shall be documented at a minimum of two locations (Top and bottom of bearing.) It is recommended that 4 locations 90 degrees apart are used.

4.3.4 Test Monitoring Procedures. The following conditions are to be monitored while conducting the Mud/Salt Water Splash test.

4.3.4.1 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 nonconformance.

4.3.4.2 Vibration. The rotating wheel bearing is to be monitored for vibration. An accelerometer attached to the bearing housing or on the rigid fixture that applies the radial load, oriented in the same direction as the radial (vertical) loading, is to be used as the transducer for measuring vibration.

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