



Wheel Bearing Sealing - Low Temperature Water Intrusion

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 a laboratory procedure for a low temperature water intrusion test of the wheel bearings for validation of 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 Applicability. This standard 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.

1.3 Remarks. This standard includes general descriptions of the laboratory test procedure for evaluating sealing of passenger vehicle wheel bearings during low temperature water intrusion testing. 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.

ISO 12103-1

2.2 GM Standards/Specifications.

GMW15760

2.3 Additional References.

- Component Technical Specification (CTS)
- Fisher Scientific, Pittsburgh, Pennsylvania (www.fishersci.com)
- Hubbard Supply Company, Flint Michigan (www.hubbardsupply.com) (Part Number (P/N) 07-SKU-517048, P/N 07-SKU-451518)
- Jade Scientific, Incorporated, Westland, Michigan (www.jadesci.com)
- McMaster-Carr, Aurora, Ohio (www.mcmaster.com) (P/N 3418K83, P/N 3418K93, P/N 3418K98)
- Powder Technology Incorporated, Burnsville, Minnesota (www.powdertechinc.com)
- 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.

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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.

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 low temperature water intrusion sealing 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.

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 (6) 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: 48 days (per six bearings)

Test hours: 140 hours (per bearing)

Coordination hours: 72 hours (per six bearings)

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.

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.

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4 Procedure

4.1 Preparation. Build appropriate fixtures for mounting the test wheel bearings in the equipment. Refer to Figure A1 (Appendix A) and the testing conditions and instructions.

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 This test is intended to assess the sealing capability of wheel bearing seals and end caps at low temperatures. Thermal cycling is used to:

- Alternately increase and decrease the pressure inside the wheel bearing.
- Increase and decrease the elasticity of the seals.
- Cause mismatches in thermal expansion and contraction where different materials are mated.

The temperature is increased by operating the wheel bearing under load, while the cooling occurs during the non-operating periods. This test should be conducted without brake parts, splash shields, or other barriers to water or contaminant entry. However, if such brake parts are included in the test setup (e.g., because they are needed for mounting the bearings), these brake parts may not limit the exposure of the seal(s).

4.2.2.2 All seals (or end caps) that will be exposed to direct splash in the vehicle application are to be run on this test. This is usually only the inboard side, due to brake components that typically provide shielding to the outboard side.

Note: An alternate test type (e.g., a dunk test) should be considered for testing both inboard and outboard seals for vehicles that are expected to be subjected to water fording conditions.

4.3 Instructions.

4.3.1 Pretest Sensor Wire/Cable Pull. Prior to beginning any sealing test, each wheel bearing design that includes wheel speed sensors of any type shall have a static pretest 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 Low Temperature Water Intrusion Test.

4.3.2.1 Preconditioning. Before being tested, the wheel bearing should be preconditioned by operating for 1 h at 1200 rpm, unloaded, at room temperature, with no water exposure. Then, the wheel bearing is to be half-submerged, placed under load, and cooled.

4.3.2.2 Thermocouple. A thermocouple is to be located on the wheel bearing exterior, near the top of the seal or end cap joint, within the shaded region shown in Figure A1 (Appendix A). The thermocouple may be coated to protect it from the salt water.

4.3.2.3 Submersion. The wheel bearing is to have its axis of rotation oriented horizontally, with the speed sensor downward, and the seal and/or end cap half-submerged in salt water. Except during the 1 h seal break-in, this submersion is required during both the running and non-running portions of the test.

4.3.2.4 Chamber. See Figure A1 (Appendix A) for an example test setup for an inboard seal. The wheel bearing and water chamber are to be inside a cold box capable of providing air temperatures below -20 °C. To achieve good cooling of the water, the water chamber should:

- Be made of aluminum (5000 series or 6061 grade recommended for corrosion-resistance; do not use cast aluminum).
- Have the smallest diameter that will fit the bearings being tested.

A U-tube connected to the water chamber should be used to verify that the water is at the proper level at the start of testing.

4.3.2.5 Water. The salt water solution is to consist of 30.2 parts $\pm$ 0.3 parts sodium chloride for every 100 parts distilled or deionized water. For clarification, this is **not** a 30.2% salt solution; rather, it is a $30.2/(100 + 30.2) = 23.2\% \pm 0.2\%$ solution. This is the optimal concentration for achieving the lowest possible temperature. A higher salt concentration would allow a salt crust to form, while a lower concentration would allow

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premature freezing of the water. See Table B1 (Appendix B) for possible sources and minimum specifications of the required ingredients.

4.3.2.6 Chamber Air Temperature. The suggested chamber air temperature is in the range of -20 °C to -26 °C throughout the test. A higher temperature will cause an excessively long cool down period. If the air temperature is set too low, however, it will increase the chance of freezing the salt water solution (which begins at about -22 °C).

4.3.2.7 Definition of One Cycle. The cycle is illustrated in Figure A2 (Appendix A). Rotation may begin any time after the thermocouple location reaches -18 °C. This is the beginning of the first cycle. On each startup, full rotational speed is to be achieved in less than 15 s. Rotation is to be at 1200 rpm, 20 minutes at a time. The peak temperature achieved after this rotation may vary somewhat with each cycle.

One complete cycle consists of one operating (heating) period, plus one non-operating (cooling) period. Achieving the minimum temperature (-18 °C) at the thermocouple is required in every cycle. At that point, the wheel bearing is to begin the next rotation period.

4.3.2.8 Wheel Bearing Loading. Loading is used to help heat the wheel bearing during the rotation period, as well as to induce distortion in the seal. A 0.3G inboard cornering maneuver is applied throughout the test, including both the rotating and non-rotating periods.

The vertical and lateral loads are calculated as follows, based on the cornering level of 0.3G.

- Vertical load at the center of the tire tread equals the value of Gross Axle Weight Rating (GAWR) divided by two (2), added to the value of GAWR multiplied by the cornering acceleration, multiplied by the ratio of Center of Gravity (CG) Height, divided by Track Width for vehicle.

Note: If specific vehicle dimensions are not available for the CG Height to Track Width ratio, use 0.43 for trucks (including pickups, vans, Sport Utility Vehicles (SUV) and crossovers), and 0.36 for passenger cars.

- Lateral load equals inboard cornering load, acting at the tire rolling radius, which equals the vertical load multiplied by the cornering acceleration level.

4.3.2.9 Test Completion.

4.3.2.9.1 Unless an Antilock Brake System (ABS) sensor fault occurs first, the test is to be run to the number of thermal cycles given in the Wheel Bearing CTS. The wheel bearing is to then be disassembled and as much of the grease as possible between the innermost seal lip and the nearest edge of the rolling elements removed. A sample of the grease must be taken from a minimum of three positions. The grease must be pulled from the most Inboard (IB) position between the IB ball row and seal. A sample of the grease should also be pulled from between the ball rows as well as between the Outboard (OB) ball row and seal. When the grease sample is pulled, it should be greater than 0.5 g and should be mixed prior to evaluation. The percent water should be confirmed for grease from each location, not an average of the water for IB, OB and between the rows.

4.3.2.9.2 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. Mount the wheel bearing sensor-side down, to maximize the fault potential.

4.3.2.9.3 The following are to be considered wheel bearing failures.

- a. During testing, any speed sensor fault.
- b. At the end of the specified number of thermal cycles, an amount of water in the grease greater than the amount specified in the CTS.
- c. At the end of the specified number of thermal cycles, any evidence of corrosion inside the innermost seal lip or inside an end cap.
- d. Unexpected failure modes, such as fractured inner rings.

Due to the amount of salt in this solution, purely cosmetic corrosion (not affecting any functions) outside of the innermost seal lip does not count as a failure.

4.3.2.9.4 Teardown and inspection of all wheel bearings shall be performed following this test, with all evidence of damage, including water intrusion and internal corrosion, to be documented. All water intrusion paths are to be identified.

4.3.2.9.4.1 During teardown, photos should be taken and should be available in the test record to show the condition of the bearing. At a minimum, the following should be included.

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