



Ball Joint Seal Test Under Simulated Environmental Conditions

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. The purpose of this test is to determine ball joint sealing performance under simulated environmental conditions representing high mileage wear and fatigue cycling.

1.2 Applicability. This test applies to all passenger cars, light duty trucks, and multipurpose vehicles.

1.3 Remarks. This test is intended to be performed by or at the direction of the design responsible ball joint supplier.

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

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.

3.2.1 Environmental chamber(s) capable of maintaining the required test temperatures and containing the mixtures sprayed onto the ball joints. These enclosures must also be capable of applying the required oscillating and rotating angular inputs to the ball joints. Capability to test six (6) ball joints simultaneously is desirable to minimize test duration for the required number of samples.

3.2.2 A pump to circulate the corrosive dirty water medium at 3 L/minute for each ball joint under test.

3.2.3 A pump capable of spraying water at 10 bar through a 3 mm nozzle.

3.2.4 A pump capable of spraying water at 80 bar through fan nozzles.

3.2.4.1 A pump to circulate the water and ethylene glycol solution, or CaCl mix, at 3 L/minute for each ball joint under test.

3.2.4.2 A Chamber capable of creating a corrosive environment, per GMW14872.

Note: All instrumentation is to be calibrated as required; record instrumentation details and date of calibration on data sheet unless the information is otherwise preserved in the testing laboratory records.

3.2.5 Material Requirements. To the extent possible, the ball joint seals should come from a population of mold cavities over time in order to comprehend as many manufacturing variables as possible. The sealing interfaces should build from production intent sample parts or fixture pieces of similar material and machined using the

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production intent process. It is critical to replicate the exact interfacing surface conditions at all of the sealing areas, (e.g., surface roughness and pattern).

3.3 Test Vehicle/Test Piece. A total minimum number of 24 test samples are required to complete this entire specification. A minimum of six (6) samples per test phase (and cycle) is required. See Appendix A, Figure A1.

3.4 Test Time.

Calendar time:	30 days
Test time:	28 days
Coordination time:	16 hours

Note: A summary chart showing the timing of each phase is given in Appendix A, Figure A2.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. The test technician should be familiar with the test machine and the instrumentation required to obtain test data.

4 Procedure

4.1 Preparation.

4.1.1 All samples must be checked to ensure conformance to all print dimensional requirements. Samples must be fixtured using the production mating to part to duplicate the exact seal interface conditions. If mating parts are not available, a representative fixture block can be used. The fixture block must be built of the same material and have the same size and shape as the production part in the interface area. Special attention to any surfaces that contact the sealing boot is needed. These surfaces must be machined to duplicate tool pattern and surface roughness of production part.

4.1.2 Pre-Conditioning. All samples must be preconditioned according to the following:

- Assemble the joints to the mating parts so the seals are at the installed height.
- Age the parts for 7 days in a forced-air oven at $70\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ (rubber boot) or $60\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ (polyurethane boot).
- Then, subject the parts to 80 parts per hundred million Ozone at $40\text{ }^{\circ}\text{C}$ for 3 days.

See Appendix B, Figure B1 for a graphical depiction of the test conditions and duration.

4.1.3 Corrosion Pre-Conditioning. The six (6) samples identified for Phase 1 testing must also be subjected to this corrosion preconditioning step. This preconditioning portion does not apply to stabilizer bar links.

Joints shall be subjected to corrosive environment, per GMW14872 using the following: Under Body (UB), All, Method 3, Exposure A. Joint samples are to undergo oscillation and rotation for a period of 8 h, followed by 16 h of rest time. See Appendix B, Figure B2 for a graphical depiction of the test conditions and duration.

4.2 Conditions.

4.2.1 Environmental Conditions. A maximum of 1 h transition time is allowed after an environmental condition change.

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.

4.3 Instructions.

4.3.1 Operating Instructions. The environmental seal tests are to be carried out on completely assembled joints using production intent mating parts or representative fixture blocks as described in 4.1.1. Parts must be oriented relative to ground (level) the same as installed on the vehicle. The tests are carried out with superimposed oscillation and rotating movement. If one of these types of movement does not occur during practical operation, then the joint will be tested with the remaining movement. Phase 1 test cycles 1 and 2 are to be carried out subsequently on the same test samples.

4.3.2 Phase 1: Wear and Fatigue with Environment.

4.3.2.1 Test Cycle 1: Wear and Fatigue at Low Temperature. Test at $T = -40\text{ }^{\circ}\text{C}$. See Appendix B, Figure B3 for a graphical depiction of the test conditions and duration. A maximum of 3 h is allowed to bring the chamber temperature from ambient to $-40\text{ }^{\circ}\text{C}$. This transition starts simultaneously with the oscillation cycling.

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Rotating and oscillation angles may be modified to better represent the vehicle application if required. Any deviations or exceptions from this requirement shall be specified on component drawings, test certificates, reports, etc.

4.3.2.2 Test Cycle 2: Leakage Test with Environment. Leakage test includes environmental simulation. The part is to be exposed to humidity, temperature, and immersed or flooded with dirty water at prescribed intervals. All sealing interfaces, including rubber boot interfaces and external closures, must be subjected to the fluid. See Appendix B, Figure B4.

4.3.2.2.1 During the oscillation rest period at hours 13 thru 17 in each day of the test, the joint is to rest at an oscillation angle of 66% of maximum drawing angle.

4.3.2.2.2 Rotating and oscillation angles may be modified to better represent the vehicle application if required. Any deviations or exceptions from this requirement shall be specified on component drawings.

4.3.2.2.3 The dirty water recipe is shown in Appendix E, Table E1.

4.3.2.2.4 An optional movement block cycle is included in Appendix C, Figure C1, and can be substituted for the oscillation and rotation angles described above if agreed upon by the responsible engineer.

4.3.3 Phase 2: High Pressure Leakage Test. See Appendix B, Figure B5 for a graphical representation of the test.

4.3.3.1 High Pressure Jet Spray. See nozzle diagram in Appendix D, Figure D1.

4.3.3.1.1 Assemble joints according to installation position at 100% of maximum articulation angle according to the drawing.

4.3.3.1.2 Spray clean water at 10 bar, measured at the nozzle, for a period of 10 minutes. Spray angle shall be set at half of maximum drawing oscillation angle.

4.3.3.1.3 Relative movement of joint to nozzle: ± 20 mm vertical at 0.6 Hz. Rotation at 1 rpm.

4.3.3.2 High Pressure (HP) Fan Spray. See nozzle diagram in Appendix D, Figure D2.

4.3.3.2.1 Assemble joints according to installation position at 100% of maximum articulation angle according to the drawing.

4.3.3.2.2 Spray clean water at 80 bar, measured at the nozzle, from four (4) fan nozzles of 90, 60, 30, and 0 degrees. Spray for 30 s from each nozzle consecutively.

4.3.3.2.3 Relative movement of joint to nozzle: rotation at 1 rpm.

4.3.4 Phase 3: Low Temperature Leakage Test: Seal Performance at Low Temperature. This test is to be run in staggered periods of movement, fluid spray, and environmental temperatures. A graphical representation of this test is included in Appendix B, Figure B6.

The part is to be immersed or flooded with a fluid consisting of ethylene glycol and water mix at 1:1 ratio, or calcium chloride and water mix at 1:2 ratio. All sealing interfaces including rubber boot interfaces and external closures must be subjected to the fluid. When transitioning from rest to movement with spray, the fluid spray must begin 1 minute before the joint movement. The rotating and oscillation angles may be modified to better represent the vehicle application if required. Any such deviations or exceptions from the specified requirement must be agreed to by the GM Responsible Engineer, and the test exception must be noted on component drawing.

4.3.5 Analysis. After the test sample(s) have completed the assigned test phase, a drying period of at least 8 h is recommended to avoid moisture intrusion during disassembly. A thorough analysis and documentation of each test sample is required.

4.3.5.1 Requirements. The minimum characteristics of each sample that must be investigated are as follows:

4.3.5.1.1 Fractures, cracks, abrasion, or abnormal shape of the sealing boot.

4.3.5.1.2 Penetration of water into the joint. This should be examined on both the seal side and, if applicable, the external closure side. The percent of water shall be determined via scientific test method (i.e., Bergof, Fischer or similar). See Appendix F, Figure F1.

4.3.5.1.3 Presence of corrosion at the ball stud or within any joint sealing area including external closures.

4.3.5.1.4 Leakage of grease.

4.3.5.1.5 Relative movement between sealing boot and ball joint housing.

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5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Results must meet the specifications as prescribed in this document and any other applicable document including drawings, Statement of Requirement (SOR), and Component Technical Specifications (CTS). Where interpretation or judgment is needed, the Product Development Team (PDT) shall review and the GM Design Release Engineer (DRE) shall provide final direction.

5.3 Test Documentation. Issue a test report documenting this test, conditions, and test results. See Appendix F, Data Sheet F1 for a sample data sheet.

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. Not applicable.

7.2 Acronyms, Abbreviations, and Symbols.

CTS	Component Technical Specification
DV	Design Validation
DRE	Design Release Engineer
GSSLT	Global Subsystem Leadership Team
HP	High Pressure
Opt	Optional
PDT	Product Development Team
PV	Production Validation
Rev	Revolution
SOR	Statement of Requirement
UB	Under Body
X-axis	Cross Axis Ball Joint

8 Coding System

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

Test to GMW15459

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9 Release and Revisions

This standard was originated in October 2006. It was first approved by Global Chassis Team in January 2007. It was first published in April 2007.

Issue	Publication Date	Description (Organization)
1	APR 2007	Initial publication.
2	MAR 2008	Added Appendix B and Appendix C; editorial corrections; corrected 9.1. (Global Chassis Team)
3	MAR 2012	Added reference GMW14872. Added paragraphs 4.1.3, and 4.3.3.1.1 thru 4.3.3.1.3. Removed paragraph 4.3.3.3 and added paragraphs 4.3.3.2.1 thru 4.3.3.2.3. Also added paragraph 4.3.5.1.5. Modified test schedule in Section 4.3. Revised Appendices A, B, and C. Added Appendices D, E, and F. Added corrosion pre-conditioning. Modified test schedules. Modified Phase 3 fluid. (Global Chassis Suspension Team)
4	SEP 2017	Revised to current template (Chassis Suspension Global Subsystem Leadership Team (GSSLT))

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