



Suspension Control Arm and Link Durability Test

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. To determine suspension control arm or link fatigue durability performance when subjected to representative loads and total fatigue damage.

1.2 Applicability. This procedure applies to all passenger car and light truck control arms and links.

1.3 Remarks. This evaluation is an accelerated means of evaluating the fatigue performance of control arm and link assemblies at the component level. This test is only a portion of the validation requirements as described on the drawing and in the Statement of Requirements (SOR).

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15760

GMW16044

GMW16285

2.3 Additional References.

Statement of Requirements (SOR), Appendix C2

3 Resources

3.1 Facilities. A bedplate large enough for securing the test rig and capable of withstanding dynamic loading of the test rig/specimen is required. A hydraulic system capable of supporting the required test loads, displacements, and rates is required.

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 The test setup and fixture shall be able to simulate the vehicle loading conditions. The loads may need to be applied simultaneously in multiple axes depending on the control arm design and vehicle application. Likely load application points are: ball joint, stabilizer bar connection, spring seat, and shock connection. The loads should be reacted through the bushings which are fixed mounted to the test fixture or representative vehicle structure. Air cooling can be used to prolong the life of the bushings. See Appendix A, Figure A1, Figure A2, Figure A3, and Figure A4 for typical test setup examples.

3.2.2 If required, means of producing cold and hot environments around the test part must be available. The typical temperature range is -40 °C to 60 °C. However, application specific temperatures may be higher.

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3.2.3 Instrumentation.

Note: All instrumentation is to be calibrated as required. Calibration traceability information is to be recorded on Appendix B, Data Sheet B1.

3.2.3.1 Controllers.

3.2.3.1.1 Test Site Controller (TSC). The TSC should be able to support block cycle testing defined in GMW16285.

3.3 Test Vehicle/Test Piece. Each test sample must meet the drawing requirements and be design intent. Data to verify compliance needs to be supplied with final test report. A minimum of six (6) samples shall be tested (three (3) right hand (RH), three (3) left hand (LH) or six (6) total if unhande(d)) for Design Validation and 12 samples shall be tested for Product Validation (six (6) RH, 6 LH or six (6) total if unhande(d)). Use GMW15760 to select samples for test. All attaching components (i.e., bushings and ball joints) shall be design intent. Alternate bushing constructions may be considered if bushing fatigue life is an issue. Alterations must be approved by GM Design Release Engineer (DRE), GM Validation Engineer (VE) and GM Subject Matter Expert.

3.4 Test Time.

Calendar time: 5 days
Test time: 95 hours
Coordination time: 6 hours

3.5 Test Required Information. All required test information shall be supplied by the GM VE.

3.6 Personnel/Skills. The test technician should be familiar with the test machine and the instrumentation required for obtaining test data. Prior experience/training in setting up and running similar tests and experience/training in the use of the referenced test equipment are required for a successful evaluation.

4 Procedure

4.1 Preparation.

4.1.1 Develop the test block cycle procedure per GMW16285. The GM VE will supply event load information and the number of repeats of each event to total one (1) life of cumulative fatigue damage. Loads should be from Road Load Data Acquisition (RLDA) or Virtual Road Load Data Acquisition (vRLDA) data. If RLDA or vRLDA data is not available, representative loads can be derived from static design loads. The developed block cycle shall represent one (1) life of cumulative damage considering all points of loading on the arm. The block cycle test may require loads to be applied simultaneously in multiple axes depending on the arm design and vehicle application. The target life cycles on the primary loading axis should be at least 200 000 cycles per life. The typical test frequency on the primary axis is 2 Hz. This speed is intended to prolong bushing life. The test can be run faster if bushing life is not an issue.

4.1.2 All samples must be checked to ensure conformance to all print dimensional requirements, material and if applicable weld requirements. Reference 3.3.

4.1.3 Test Setup. The samples should be installed in the vehicle design position including proper fastener torque. All fasteners and attached components are to be paint indexed to indicate movement. Mating parts must have design intent material, dimensions, surface treatments, and coatings. White paint may be applied after the test setup is complete to facilitate crack detection.

4.2 Conditions.

4.2.1 Environmental Conditions. Typically, control arm and link durability tests are run at ambient temperature. However, if the part is close to a heat source in the vehicle, or if interfacing components are known to be susceptible to temperature extremes, then environmental controls will be required. If environmental conditions are necessary, run 15% cold (-30 °C), 70% ambient, and 15% hot (60 °C). Environmental conditions may be modified to simulate actual vehicle application.

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 Test should be run under load control with logical displacement limits set during drive file development.

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4.3 Instructions.

4.3.1 Initiate test to developed block cycles.

4.3.2 Monitor load, displacement and cycles to failure per Appendix C2 of SOR. All observations should be noted and documented with picture along with the cycle count, block and percent of test.

4.3.3 Lower Control Arm (LCA). Block cycle loading is defined by GMW16285 (or Computer Aided Engineering (CAE) based static loads) based on the vRLDA or RLDA in the before/after, cross car and vertical direction. The vertical load is suspension dependent and may be omitted based on engineering and validation direction. If applicable, the spring load should be represented by the worst-case springs (highest stiffness) or representative spring fixture. If applicable, represent the shock load or fixture at the shock attachments. If applicable, test indirect Control Arm stabilizer bar attachments to failure based on the vehicle worst case stabilizer bar durability block cycle data. See Appendix A, Figure A5 for required load vectors.

4.3.4 Upper Control Arm (UCA). Block cycle loading is defined by GMW16285 (or CAE based static loads) based on the vRLDA or RLDA in the fore/aft ($\pm x$ in global coordinates), cross car ($\pm y$ in global coordinates), and vertical ($\pm z$ in global coordinates) directions. Loads in x, y, and z directions can be decoupled. Run the link durability with the upper limit bushing rates based bushing supplier test/estimates and on CAE fatigue damage predictions, design configurations and extreme position assessments. Cooling is required for the bushings. Bushings that fatigue during testing should be replaced. See Appendix A, Figure A5 for required load vectors.

4.3.5 Link Durability. Fixture and load the link in vehicle position. Run the link durability with the upper limit bushing rates based bushing supplier test/estimates and on CAE fatigue damage predictions, design configurations and extreme position assessments. Cooling is required for the bushings. Bushings that fatigue during testing should be replaced. Run the component level block cycle for a lateral link to include vertical (torsion around the bushing), axial and bushing coning inputs, in addition to the axial link load (bushing radial load). The axial load should be load controlled and displacement should be monitored. The perpendicular load to the axis of the link must run in displacement control and load should be monitored. See Appendix A, Figure A6 for required load vectors.

5 Data

5.1 Calculations. Calculate the Weibull life, per Appendix C2 of SOR. Appendix C, Figure C1 shows a typical Weibull calculation. Appendix C, Figure C2 shows why it is important to test RH and LH. In this example, they are two distinct populations so the data could not be plotted as one set of data.

5.2 Interpretation of Results. A full Design Review based on Test Results should be conducted to document all observations and potential concerns. Reference GMW16044.

5.3 Test Documentation. Report the test and inspection results on a Data Sheet. Reference Appendix B, Data Sheet B1.

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.

CAE	Computer Aided Engineering
Cert	Certification
CTS	Component Technical Specification
DRE	Design and Release Engineer

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