



Multi-axis Seat Subsystem Durability Test

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 procedure evaluates the structural durability of a front or rear seat subsystem by subjecting it to real time load and displacement profiles. These profiles are designed and developed to represent a lifetime usage. This procedure describes the durability test execution.

1.2 Foreword.

1.2.1 This procedure is primarily intended for laboratory test engineers and technicians. It does not cover every possible aspect of durability testing and is not to be used as a stand-alone procedure. Successful durability testing inherently requires engineering judgment and the ability to recognize and solve problems which are unexpected and/or complex.

1.2.2 This procedure utilizes a generic profile developed from Road Load Data Acquisition (RLDA or vRLDA), drive file development and correlation evaluation. The time required has been reduced by utilizing the damage cycles of a typical seat system and is provided in the appropriate Subsystem Technical Specification (SSTS) or Component Technical Specification (CTS). However, if a new architecture is developed, a new profile can be developed.

1.3 Applicability. This procedure applies to all free standing seats or partially free standing seats for GM passenger cars, Sport Utility Vehicles (SUV) and light and medium duty trucks.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15219 GMW15245

2.3 Additional References.

- Component Technical Specification
- Subsystem Technical Specification

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 required. Also required is a hydraulic system capable of supplying oil at a rate consumed by a Multi-axial Simulation Table (MAST). The test facilities and equipment shall be in good working order and all instrumentation shall have a valid calibration label.

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. Note: The following list(s) include test rig, fixtures and transducers typically used by the GM Structural Development Laboratory to perform this test. Other equipment may be substituted at the discretion

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of the local testing facility, as long as it provides the same data and/or data record with equivalent accuracy as specified herein or by the requestor.

3.2.1 Test Rig. A simulation table capable of controlling 3 degrees of freedom, (vertical, lateral, and fore-aft). Also a multi-axis table with 6 degrees of freedom can be used. A typical MAST table in current usage at GM with 3 degrees of freedom is shown in Figure A1. Alternative test equipment is also shown in Figures A2 and A3.

3.2.1.1 The simulation table surface area should be adequate to mount the test specimen and the appropriate fixtures. The hydraulic actuators should be sized appropriately to reproduce the acceleration as provided in the SSTS.

3.2.1.2 Fixtures. Fixturing is required to support the test specimen in its test position.

3.2.1.2.1 Fixture for Front Seats. A means to support the front seat system including rigid mounting blocks, or equivalent, simulating the floor attachment points to mount the seat system in the test position on the MAST. A typical fixture for front seat subsystems is shown in Appendix B, Figure B1.

3.2.1.2.2 Fixture for Rear Seats. A means to support the rear seat system including rigid mounting blocks, or equivalent, simulating the attachment points to the vehicle. A fixture simulating the body is used for rear seat subsystems.

3.2.1.3 Loads. Loads as required in the SSTS to be added to the seat during durability testing. If no weight is specified, then the following default weights may be utilized. This test can also evaluate the seat in the fold down position with weights of 10 kg as shown in Appendix D, Figures D1 and D2.

3.2.1.3.1 Dummy. Dummy to simulate occupant of a 95% (90 kg) for outboard positions, and 50% (70 kg) for center. Typically water dummies with the approximate weights are utilized.

3.2.2 Transducers.

3.2.2.1 Accelerometer. Accelerometers are used to match the acceleration data that is provided in the SSTS or CTS as specified. The default accelerations in Appendix B, Table B1 may be utilized if approved by the GM responsible engineer. Remote parameter response coherent with the given direction for each actuator is required for each of the hydraulic actuators controlling the motion of the table. Acceleration responses must be collected on the rigid body and/or frame side as required. It is important to insure that there are not additional accelerations being generated by less than robust attachment to structure.

3.2.2.1.1 Loads/Strains. Loads and strains on the specimen can be used in a non-square matrix as additional control channels or for correlation.

3.2.2.1.2 Torque Wrench. A torque wrench is used to tighten all threaded fasteners to the specified torque.

3.3 Test Vehicle/Test Piece. Complete trimmed seat subsystem in the heaviest version. An appropriate seat subsystem consisting of all components necessary to qualify as complete for the model and trim level specified by the Design Release Engineer. This test can be completed on seat structure only by massing out the structure to represent the missing components and simulating the center of gravity of a trimmed seat.

3.4 Test Time. The following is an estimate of the amount of time (work hours) needed to perform this procedure.

Note: These time estimates are approximate averages. Actual times vary considerably depending on early component failures (and subsequent availability of replacement parts), testing to varying multiples of cycle lives, scheduling problems for test facilities, test equipment malfunctions, scheduling of overtime and/or multiple shifts, actual readiness of test samples upon receipt, unique or additional requests for detailed test information, running multiple samples (times shown are for one sample), etc.

The reported times consider preparation and other downtime, actual test, and analysis of data in capturing a total calendar time. They are estimated ranges for a typical durability test and will vary based upon the chosen durability schedule. Report writing, approval, processing, etc., are not part of the reported times.

Calendar time: 9 to 15 days

Test hours: 70 to 120 hours

Coordination hours: 1 to 8 hours

3.5 Test Required Information. The requesting engineer is responsible for identifying the durability schedule to be simulated and provide test specifications, SSTS or CTS paragraph numbers, appropriate to the component/subsystem being tested.

3.5.1 Time History Data. RLDA data should be provided to the test lab in Remote Parameter Control (RPC) III format. File names must adhere to the local standard naming convention (reference GMW15219 for the appropriate file naming convention). Modifications to the provided data should be documented in the RLDA report.

3.5.2 Durability Part Information. Part numbers, design level, Uniform Part Classification (UPC) codes, Functional Name Address (FNA) codes, etc., must be provided for the production intent material to be evaluated during the test. Fastener torque specifications must be provided along with assembly sequences that may apply to properly assemble the test specimen.

3.5.3 Test Inspections. The minimum lab practice is to inspect the test specimen three times per 8 h shift during durability testing. Any increase in inspection frequency should be specified by the requester at the start of durability testing.

3.6 Personnel/Skills. 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. This experience is also critical to achieving the estimated times shown in 3.4.

4 Procedure

4.1 Preparation.

4.1.1 Test Profiles. The profiles are to be obtained from the CTS or SSTs.

4.1.2 Test Development. The goal in test development is to reproduce the system response measured on the road during the RLDA. The input files are provided in the CTS and SSTs; if there is none provided, then the default inputs can be utilized from Table B1 in Appendix B. The default time for the generic profile is 67 h.

4.1.2.1 Inspect Hardware. The seat structure hardware should be inspected upon receipt. Ensure that all hardware needed to develop the test has been provided or is available at the test site.

4.1.2.1.1 Perform Instrumentation Checks. Prior to assembly, perform a function check of the transducers. Connect the transducers to the instrumentation and perform standard balance, calibration, and polarity checks.

4.1.2.2 Prepare Test Development Specimen. The test and requesting engineers should inspect the specimen to insure all material listed in 3.3 is of correct design level and assembled properly for test development. Obtain approval from the requester utilizing local test lab approval documents.

4.1.2.2.1 Installation of Seat into Fixture. Install the seat subsystem on the MAST table with a suitable fixture which simulates the seat attachments to the vehicle.

4.1.2.2.2 Prepare Test Development Specimen. If a new test development specimen has to be prepared, the test requester has to provide the necessary measurement positions. The measurement positions, sensor type and settings are listed in the final report. Place accelerometers at the attachment areas of the seat subsystem. The acceleration inputs are to be verified. Once there is verification of the inputs, the test may be started. The placement of transducers or sensors is shown in Figures C1, C2, C3, C4 and C5 and can be utilized to measure the response of the inputs.

4.1.2.3 During the Test. The Test Site Controller (TSC) is used to control the test rig and the instrumentation associated with the test specimen. System response is collected using the RLDA hardware on the test rig in conjunction with the TSC. The TSC, running RPC programs, is used to manipulate data in the time and frequency domains allowing the creation of test rig drive files that are used to control the motion of the test rig.

4.1.2.3.1 Calculate Frequency Response Function. Test rig drive file development begins with calculating a Frequency Response Function (FRF) for the test rig system. The FRF is a matrix math model that describes the relationship (amplitude and phase) of the inputs (test rig drives) specified frequency band. The inverse FRF is used to estimate/correct the test rig drives over the specified frequencies. The typical frequency control band for the simulation table drive is 0.4 to 50 Hz. The FRF must encompass all frequencies in the control band. When establishing the control band for the test rig, consider actuator displacement limitations and test rig/fixture resonance.

4.1.2.3.2 Iterate Test Rig Drive Files. Test rig drive file development continues through an iterative process utilizing the FRF. An initial test rig drive is estimated based upon the desired RLDA response and the relationship predicted by the FRF for drive and response. The initial drive is played out to the test rig at partial amplitude (gain control) because the FRF is a linear approximation of a non-linear system. A new system response is collected for the initial drive and compared to the desired RLDA response. The resulting error is

used to correct/adjust the initial drive. The new test rig drive is played out and the process is repeated (next iteration). This continues until the system response matches the desired RLDA response.

4.1.2.3.3 Collect Final Response. Upon completion of test rig drive file iterations, a system response corresponding to the final test rig drive must be collected for correlation purposes. The system final response(s) should include all test rig and system transducers.

4.1.2.3.4 Archive Data. The test rig response and drive files should be preserved for future reference (in the event that the test must be reproduced at a later date). Archive test development data per local laboratory practice.

4.1.2.4 Test Development from Test Rig Responses. When attempting to recreate a previous test, or if a change has been made to the test rig, test rig drive files may need to be adjusted. The process of developing test rig drive files in this manner is referred to as iterating test rig drive files to test rig responses.

4.1.2.4.1 Develop the Test. This process is the same as specified in 4.1.2.3 with one exception. The desired response referenced in 4.1.2.3.2 is a test rig response collected from a prior test development, rather than an RLDA response. Test correlation, as specified in 4.1.2.3.4, will be to the prior test rig response (or an original remote parameter) rather than the road baseline.

4.1.2.5 Time and Pseudo Damage Optimization. The target test time for the typical durability test is approximately 70 to 120 h. Pseudo damage retention targets are specified in GMW15245. If the specified targets have not been achieved for time and pseudo damage retention, consult the local test expert/mentor for assistance.

Note: Multiplier optimization is the process by which the prescribed test module repeats are manipulated in the interest of saving time. It is also used to increase or decrease pseudo damage retention on individual channels or the test as a whole. Caution must be exercised when optimizing repeats. An unrepresentative test can result if not properly performed.

4.1.2.6 Remove RLDA hardware, transducers, and miscellaneous cables and return them to the proper storage location.

4.1.3 Durability Test Execution. This test is normally run on the test specimen in an “as-received” condition. If the test is run in a specifically requested condition, follow the applicable procedure(s) provided by the requestor.

4.1.3.1 Facilities and/or Equipment Preparation.

4.1.3.2 Durability Test Specimen Installation. Specimen assembly and installation should follow the sequence prescribed by the assembly documents or instructions specified by the requester. Fasteners should be installed to minimum torque specifications unless specified otherwise by the requester. Care should be taken to not preload the system in a way unrepresentative of design.

4.1.3.2.1 Mount the seat subsystem with the appropriate model floor mounting blocks or fixture to the MAST.

4.1.3.2.2 Adjust the seat subsystem to the test position as described in 4.2.3.

4.1.3.2.3 Equip the seat subsystem with the required loads as described in 4.2.3.

4.1.3.3 Durability Test Specimen Pre-inspection/Sign Off. The test and requesting engineers should inspect the specimen hardware to insure all material listed in 3.3 is of correct design level and assembled properly for durability testing. Obtain approval from the requester utilizing local test lab approval documents.

Note: A light application of flat white stencil ink/paint will highlight cracks in metal components. Consult the requester as to the compatibility of the stencil ink with plastic or rubber where applicable before applying. Index fasteners with paint pen, torque seal, or equivalent to enable visual inspection of fastener movement from initial position.

Note: Test rig tuning should be verified with the specimen installed on the table if a test development did not occur for the durability test.

4.1.3.4 Setup Test Site Controller. A test made up of the test rig drive files created during test development has to be created on the TSC. The process of creating a test and creating a playback matrix on the TSC is automated by the TSC software.

4.1.3.4.1 Setup Input/Output (I/O) Properties on TSC. There are digital and analog inputs/outputs on the TSC. Connect the drive signal and MAST system response cables to the TSC and the hydraulic controller.