



Midsize Truck Pickup Box Bench 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. This procedure introduces an alternative method to evaluate the structural performance of a Midsize Truck (MST) Pickup (PU) Box subsystem. It establishes a laboratory durability test based on real-time road load data that were collected on proving ground test tracks. It describes the test preparation and durability test execution.

It can also be applied to evaluate structural modifications on the PU Box structure prior to a full vehicle lab or road durability test, or be used as a comparative test, between a baseline and a proposed part.

1.2 Applicability. This procedure is used for MST PU Box subsystem development. It is performed by GM laboratories as a local development test. This procedure does not provide a total vehicle durability test. The test shall be performed according to requirements specified in the Development Plan or Test Request (Activity Request (AR) in Program Quality Management System (PQMS)) issued by responsible areas (Subsystem Management Team (SMT)/Program Validation Engineer (PVE)/Design Release Engineer (DRE)).

1.3. Remarks. This procedure was intended to be an alternative test method to evaluate the structural performance of a MST PU Box, and was based on the necessity that to have a short, low cost and reliable test to help the development of the PU Box structure, due to time and hardware constraints. It is primarily intended for laboratory test engineers and technicians, and it does not cover every possible event of road simulation testing, and is not to be used as stand-alone procedure.

A successful road simulation testing inherently requires engineering judgment and the ability to recognize and solve problems which are unexpected and or complex.

This procedure typically requires a Road Load Data Acquisition (RLDA) or Virtual Road Load Data Acquisition (vRLDA) drive file development and correlation evaluation. In Appendix A, Figure A1 shows the basic process of this procedure. The drive file development time can be reduced if previously developed drive files could be used or modified, but this approach may result in reduced correlation to the proving ground road durability test (engineering judgment). The simulation process is intended to produce laboratory road simulations for specific vehicle systems or subsystems. It means that a set of drive files will closely reproduce measured responses from remote parameters and correlation transducers for one vehicle or system with a specific combination of ballast condition, ballast position, body stiffness distribution, and chassis components. If any of these characteristics are changed, the degree of laboratory-to-road correlation is compromised. However, the team involved on the activity (Test Requester, Validation Engineer, Test Engineer) can together evaluate the risk related with this compromise and decide the acceptable minimal correlation. Compacting and reducing the number of events, by simulation process, significant time and cost reductions are obtained, always considering the engineering judgment. Similarly, the selection of the specific test rigs/procedures to be used can have a significant effect on the test quality and duration.

Also, this procedure refers to other procedures which contain detailed information that is closely tied to specific equipment or software. These procedures are intended to be used with guidance from experienced personnel.

This procedure does not provide a total vehicle durability test.

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

March 2015

Page 1 of 15

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14048 (ID)	GMW15244	GMW15269
GMW15189	GMW15245	GMW15729

(ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References.

- GM Global Evaluation Report process and CG190 Evaluation Report Template - <https://gmweb.gm.com/sites/ER/Pages/default.aspx>. (**Note:** Suppliers shall work with the responsible GM Engineer to obtain a copy of this report template.)

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.

Note: The following list includes the equipment typically used by the GM Brazil Structural Laboratory to perform durability tests. Other equipment may be substituted or added according to the test requirements and test facility availability.

3.2.1 Test Fixtures. The test fixtures that are required to perform the test must be designed and constructed according to the vehicle and PU Box characteristics (e.g., actuator attachments). See Section A2 in Appendix A (Figures A2, A3 and A4) for an example of the test fixture.

3.2.2 Servo-Hydraulic Actuators and Servo-Valves. According to the test requirements, the test system can be assembled with up to 7 servo-hydraulic actuators.

The specification of the actuators is typically required with a minimum force and displacement of 50 kN and 250 mm, depending on the road input and desired outputs measured on the road.

A minimum servo-valve size used for this test is 56 L/minute. Typically two servo-valves are used for each actuator.

Depending on the required/desired outputs actuators with 3-stage valves can be installed.

3.2.3 Linear Variable Differential Transformers (LVDT). These transducers are used to measure the displacement input to the test rig by the actuators. Seven LVDTs total (one for each actuator) are required.

3.2.4. Triaxial Accelerometers and Strain Gages (Auxiliary Inputs of Remote Parameter Control (RPC) or Similar Control Software). These transducers are used to collect the road data and to prepare the drive file through the iterative process of the control software. Typically, RLDA team is responsible for these transducers installation and calibration. Strain gage positions are defined by Computer Aided Engineering (CAE) Analysis and Technical Expertise Evaluations.

3.2.5 Signal Conditioners. The transducers (accelerometers and strain gages) require signal conditioners in order to adjust the measured value to the controller inputs.

3.2.6 Instrumentation.

3.2.6.1 Data Acquisition System. The RLDA team is responsible to provide the data acquisition equipment and transducers that are used during the RLDA and for developing the drive file. The RLDA team is also responsible to run the data acquisition on the tracks that are defined on the Structural Durability procedure. Considering a MST, the tracks, laps and ballast conditions are defined in GMW15729.

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

March 2015

Page 2 of 15

3.2.7 Controllers.

3.2.7.1 Drive File Generator – Iteration and Analysis Procedures. This equipment and software is used to develop the drive file and play it out to the test rig during the test (e.g., MTS RPC).

3.2.7.2 Servo-Controller. The servo-controller provides the closed-loop control to the servo hydraulic system (e.g., MTS 407 or Flex Test System or similar).

3.3 Test Vehicle/Test Piece.

3.3.1 PU Box. An instrumented part is required in order to procedure the drive file development. The same part from data acquisition step should be used to develop the drive file.

3.3.2 RLDA Hardware. The instrumentation is based on accelerometers and strain gages that are located at positions defined by CAE analysis and technical evaluations performed by SMT, RLDA and Test Lab expertise. Normally, the instrumentation comprehends the PU Box and the frame of the vehicle. See also 3.2.4.

3.3.3 Frame. A frame assembly (rear portion) is used as fixture in order to support and install the PU Box on the servo hydraulic system (actuator assembly).

3.4 Test Time.

Test Site Build	2 w to 4 w
RLDA	2 w to 4 w
Drive File Development	3 w to 6 w
Durability Test (per life):	25 d to 40 d

3.5 Test Required Information. The requesting engineer is responsible for providing specifications appropriate to the particular part being tested.

3.6 Personnel/Skills. A knowledge of road simulation techniques is mandatory to perform this test. Also, a skilled technician is mandatory to operate the system and follow the durability test.

4 Procedure

4.1 Preparation. The test and requesting engineers shall inspect the test items to insure all material listed are of correct design level and assembled properly. Check for cracks, paint chips, dents, etc., and document any variation/deviation in assembly, etc.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

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. Test Plan. Before starting the activity, a test plan shall be prepared showing all related activities (including the RLDA activity) in order to permit the follow up of the test progress.

4.3.2. Test Procedure. The principle testing method is based on GMW15189 (Full Vehicle Multi-Axial Inertially-Reacted Real-Time Laboratory Road Simulation Structural Durability Test) to develop the PU Box subsystem test. See Figure A1 for a pictorial view of the process.

The test procedure (test recipe) is based on GMW15729 (Midsize Truck Developing Road Regions Structural Durability Test) which defines the durability tracks for MST structural durability.

4.3.3. RLDA Instrumentation Points Definition. In order to get good road correlation, triaxial accelerometers shall be installed on the frame and PU Box that will collect the road data. A minimum of 4 accelerometers shall be installed on the frame: 2 on each frame side, at a front and rear position with the front accelerometer positioned at the middle of the frame and the rear one near the rear spring attachment.

Also, an additional 4 accelerometers shall be installed on the PU Box corners or upper edge surfaces (depending on the surface stiffness – high stiffness is recommended) in order to measure the PU Box behavior and help in the drive file preparation.

Also, the PU Box shall be instrumented with strain gages at the high stress points (defined by CAE, experienced users and/or the Global Structural Durability Laboratory Expert Team) in order to keep the process more robust.

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

March 2015

Page 3 of 15



Documents

Document Sharing Hub

4.3.4. Bench Construction – Test Fixture Preparation. A MST PU frame is the main fixture of the bench. In order to save test space and focus on the PU Box attachments, the front portion of the frame can be cut out, keeping only the rear portion - starting at the middle of the wheelbase to the rear end.

The front vertical actuators are positioned on the frame at the middle of the wheelbase length, in order to keep the torsional displacement at the lowest level.

The rear vertical actuators are positioned at the rear attachment of the rear spring or next to it, depending on the assembly of the system. The lateral actuators are positioned on the frame at the front vertical actuator plane and at the rear axle vertical plane respectively.

The longitudinal actuator is positioned on a center cross member located at the frame or at a device that simulates a cross member. The actuators shall have swivels on both ends and care must be taken for attachments to the frame to avoid cracks.

Welding test fixtures on the truck frame shall be avoided. It is permitted for some of the frame holes or constructing a device that compresses the frame parts (i.e., acting as a vise).

The actuators are positioned according to the following scheme:

- 1st row of vertical actuators (LH/RH) is positioned on the middle of the wheelbase length.
- 2nd row of actuators (LH/RH) is positioned near the rear attachment of the rear springs.

See Figures A2 thru A10 in Appendix A.

4.3.5. RLDA Collected Data Analysis for Test Tracks Definition - Damage Assessment.

4.3.5.1 After the RLDA process, it is necessary to check the recorded signals in order to verify measurement problems such as defective channels, spikes and polarities.

4.3.5.2 After the data is checked, it is possible to start a damage analysis in order to identify the events or tracks that only have the highest influence to the PU Box structural performance.

4.3.5.3 Following the procedure outlined in GMW15269 (Structural Durability Pseudo-Fatigue Analysis) it is possible to define the tracks that have the highest fatigue damage contribution at the PU Box. Figures A11 and A12 in Appendix A exemplify this analysis.

4.3.5.4 This damage assessment is based on the strain gages applied on the PU Box. (The gage positions are defined by CAE and road durability history).

4.3.5.5 Figure A13 in Appendix A exemplifies a final table that shows the values found using the process defined in GMW15269.

4.3.5.6 An engineering judgment (with all areas involved) defines the final events or tracks that will be submitted to the iterative process to obtain the drive file for testing.

4.3.5.7 An optimization of the schedule (number of the final events or tracks) can be performed in order to keep the retained damage at 100% level, according to GMW15269.

4.3.6. Test Severity Comparison (Road vs. Lab) by Energy Calculation. According to GMW15244 Pseudo-Energy Editing Method, an energy calculation based on the accelerometers applied on the PU Box can be performed in order to check the test severity, comparing the raw data and edited data. Figure A14 in Appendix A shows an example of this analysis.

4.3.7. Drive File Generation. During the drive file generation process, some parameters shall be established according to system response (test equipment and specimen) such as the Frequency Response Function (FRF) cut frequency. Usually, the frequency range is set from 0.8 Hz to 50 Hz. The iterative process (see Figure A1) to define the drive file shall continue until the error achieves a minimum value agreed by the team – test sign off (other frequency range can be set according to road inputs and bench responses).

During the drive file generation and to get the agreement on the final generated drive file, GMW15245 is followed to verify the road and lab responses meet the acceptable correlation criteria.

4.3.8. Test. After the drive file is defined, the durability test can be performed. The control software can be programmed to execute the test schedule according to procedure.

4.3.9. Test Inspections. Regular inspections shall be executed during the test according to team definition. This is normally performed on a daily basis. Inspections also include visual analysis with a stencil ink aid in order to identify cracks or other issues. GMW14048 (Global Validation Criteria for Structural Durability and Strength) is used to define the issues.

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

March 2015

Page 4 of 15

Documents
Document Sharing Hub

4.3.10. Test Report. The test and the issues found are reported in an Evaluation Report. The template can be found in Global Document Management (GDM) – CG190 Evaluation Report Template.

5 Data

5.1 Calculations. The calculations related to 4.3.5 and 4.3.6 are usually performed by MTS RPC Pro software according to GMW procedures as outlined.

5.2 Interpretation of Results. The issues found on the test are evaluated according to GMW14048 – Global Validation Criteria for Structural Durability and Strength, and addressed by the respective Team.

5.3 Test Documentation. The results of the measurements shall be presented in an evaluation report.

6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

7 Notes

7.1 Glossary. Not applicable.

7.2 Acronyms, Abbreviations, and Symbols.

AR	Activity Request
CAE	Computer Aided Engineering
DRE	Design Release Engineer
FRF	Frequency Response Function
GDM	Global Document Management
GSDLET	Global Structural Durability Laboratory Expert Team
LVDT	Linear Variable Differential Transformer
MST	Midsize Truck
PQMS	Program Quality Management System
PU	Pickup
PVE	Program Validation Engineer
RLDA	Road Load Data Acquisition
RPC	Remote Parameter Control
SMT	Subsystem Management Team
vRLDA	Virtual Road Load Data Acquisition

8 Coding System

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

Test to GMW17243

9 Release and Revisions

This standard was originated in September 2014. It was first approved by the Body - Global Structural Durability Laboratory Expert Team (GSDLET) in March 2015. It was first published in March 2015.

Issue	Publication Date	Description (Organization)
1	MAR 2015	Initial publication.

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

March 2015

Page 5 of 15