



Lateral Load Schedule Data Preparation

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.

This procedure can be applied to any real-time lateral load road data intended for use on an inertia reacted multi axis road simulator, but is currently intended for implementation on the MTS 329 Light Truck and MTS 329 Passenger Car Road Simulators. Refer to GMW15189.

1.1 Purpose. The purpose of this procedure is to define a common data preparation process for simulating proving ground lateral load events due to turning in the test laboratory on inertia reacted multi-axis road simulator.

1.2 Foreword. Not applicable.

1.3 Applicability. The application of this procedure includes but, is not limited to, High G, Square Turn, Seven Sisters, L-turn, and City real-time lateral load schedules. Because the lateral loading is being “accelerated”, it is important to prevent abrupt movement of water dummies, ballast bags, etc., inside the vehicle to prevent unrealistic damage.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15189

GMW15268

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. Not applicable.

3.3 Test Vehicle/Test Piece. Not applicable.

3.4 Test Time. Not applicable.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Not applicable.

4 Procedure

4.1 Preparation. Not applicable.

4.2 Conditions. Not applicable.

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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. Inertia reacted road simulator real time road events at or near the limit of lateral tractive capability require displacements that would exceed the capability of the road simulator. In order to facilitate these road events in the test laboratory, the real time lateral events are compressed so the event can be achieved within the displacement constraints of inertia reacted multi-axis road simulator. Time compression is a method of shortening the road data time history by decimating or eliminating sampled data points. When the compressed file is played at the original sample rate, the event is executed faster than real time. That means the frequency spectrum of the event is shifted along the frequency axis. Because inertial reaction forces increase in proportion to the square of frequency, and in direct proportion with displacement amplitude, a gain can be achieved by trading off the amplitude required to generate load with an increase in frequency. In short, with the data compressed, the simulator displacement required to obtain the road loads is shifted into the working range of the road simulator. This technique of time compression provides an opportunity of reproducing the lateral peak loads.

This technique requires sound engineering judgment and may not work as written on all vehicle platforms. Therefore, modifications and/or variances may be required to allow this process to work for each application.

4.3.1 Data Import. Import data files into a Remote Parameter Control Process (RPC Pro) project.

4.3.2 Lap Identification (as required). If multiple laps are recorded of a schedule during the Road Load Data Acquisition (RLDA), a representative lap needs to be identified for use. Optimally, the lap that is selected contains the maximum and minimum load value across all the lateral load and camber moment channels. Since these peaks typically do not occur during the same lap, you may need to selectively choose which lap to use. At times an overall peak may be sacrificed on a channel to select a lap where the overall amplitudes are consistent. A lap to lap visual comparison must be done to all the lateral load and camber moment channels. To do this, visually compare like channels with the time history plotter. For example, the left front lateral load compared to the right front lateral load or left front camber moment load compared to the right front camber moment load. The lap that is selected will contain the peak loads, or close to peak loads, across some of the channels along with having consistent amplitudes for the other lateral loading events.

4.3.3 Extract Channels (as required). This is an optional step to be used if there are more channels in the file than what is required for the drive file development process or if the channels require reordering. The required channels are listed in Table A1 and are part of the Structural Laboratories Channels to Record test procedure, GMW15268. The channels should be put in the same order as the other data files.

4.3.4 Pre-Edit (as required). Portions of a schedule may contain access roads and/or vehicle repositioning maneuvers that are not a part of the durability schedule. Select these portions of the schedule using the EDITOR tool. Remove the selected portions of the schedule using the EDIT Time History (TH) tool. See Figure B1 for a visual example.

4.3.5 Append Time History (as required). When the RLDA is performed some real-time lateral events, within the schedule, do not contain enough time between events. In order to provide enough time between the events, appending the time history must be performed on the selected schedule. This will generate two repetitions of the schedule in one file. See Figure B2 for a visual example.

4.3.6 Select Events. Using the EDITOR tool define the events to be retained and the events to be zeroed out. When selecting events ensure that the reaction load generated from the body on the lateral and camber moment channels is retained in the event. See Figure B3 for an example time history plot of a body reaction load. If 4.3.5 (Append Time History) was performed, the time history now has two repetitions of each event. Select every other event along with any other portion of the file that can be zeroed out with the REGION SELECTION tool on the lateral and camber moment channels. When doing this you must have all four laterals load channels open simultaneously. Save the areas selected as a region file named bet2_rgn. Zero the selected regions on the lateral and camber moment channels using the REGION SCALE and OFFSET tool. See Appendix C for the suggested data preparation parameter values. See Figures B4 and B5 for a visual example of the regions marked and scaled to zero.

4.3.7 Add Offset. Scale the regions on the lateral and camber moment channels to the static offset values of the wheel force transducer lateral and camber moment channels with the vehicle on the simulator at ride

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height using the REGION SCALE and OFFSET tool. See Appendix C for the suggested data preparation parameter values. See Figure B6 for a visual example of the offsets added to the selected regions.

4.3.8 Region Combining. Perform a logical not across all channels of the bet2_rgn file using the REGION COMBINING Tool. Call the output file event1_rgn. See Appendix C for additional information and the suggested data preparation parameter values. See Figures B7 and B8 for a visual example of the regions selected to compress.

4.3.9 Compress 90%. Apply the event1_rgn file to the *Filename_rsp3* file using the COMPRESS tool. Select 0.9 as the compression ratio. Note, the COMPRESS program only allows files to be compressed from 10% thru 90% in 10% increments. Save the output file as *Filename_rsp4*. See Appendix C for the suggested data preparation parameter values.

4.3.10 Compress 95%. Run the time history EDITOR tool. Open the *Filename_rsp4* file. It is recommended to create a temp_rgn file to mark the same event areas to be compressed as before. DO NOT mark the entire file for compression unless there is more than 2 s of dead time between each event. Otherwise, mark only the peak lateral regions. When doing this you must have all four laterals load channels open simultaneously. See Figure B9 for an example of the peak lateral region selection. See Figure B10 for an example of a whole file region selection. Select the time history *Filename_rsp4* and temp_rgn files as input to the COMPRESS tool. Select 50% compression. Save the output file as *Filename_rsp5*. See Figure B11 for an example of file with lateral events compressed to 95%. See Appendix C for the suggested data preparation parameter values.

4.3.11 Final Compress. Create a temp_rgn file to select specific events using the EDITOR tool. Compress each event to achieve an event time of 0.14 s to 0.20 s in duration. The duration of 0.14 s is preferred. Repeat this step until each event within the time history has an event time between 0.14 s to 0.20 s. Save the output file as *Filename_rsp6*. See Figure B12 for a visual example of an individual lateral event selected for compression. See Appendix C for the suggested data preparation parameter values.

Note: The recommended event duration of 0.14 s to 0.20 s is based on experiment and observation over many inertia reacted multi-axis road simulator test developments.

4.3.12 Event Spacing. Reduce excess time between the events and at the beginning and end of the file to minimize durability run time. Event spacing should be a minimum of 0.75 s. The total time retained must not be less than 2 frames of data. Create a region file named clean_rgn using the EDITOR tool. Apply the region file to the *Filename_rsp6* file using the EDIT TH tool. Save the output file as *Filename_rsp7*. See Figure B13 for a visual example of the regions selected for removal. See Figure B14 for a visual example of the file after the excess time has been removed. See Figure B15 for a visual example of a compressed event. See Appendix C for the suggested data preparation parameter values.

4.3.13 Event Scaling (as required). If the lateral loads are not being achieved, consider scaling up the unfiltered desired file (*_EDT in RPCpro) by 10% to 15%. This should be done on a per axle basis by scaling both the lateral and camber moments. Scale the event only. Do not scale the static offset between events. See Appendix C for the suggested data preparation parameter values.

4.3.14 Transfer Function. Transfer functions should be calculated with the control bands outside of the test data control bands. This eliminates calculating a new transfer function for each schedule. It also minimizes the transfer function roll off within the data control band. Typical transfer function control bands are shown in Table 1 Channel Frequency Control Band.

Note: A lower control frequency of 0.2 Hz means to zero out from 0 Hz to 0.2 Hz.

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Table 1: Channel Frequency Control Band

Direction	Lower Frequency (Hz)	Upper Frequency (Hz)
Vertical	0.2	50
Lateral	0.2	50
Longitudinal	0.2	50
Powertrain Torque	0	50
Brake Torque	0	50

Note: Magneto Resistive (MR) Shocks should always be provided a control signal, even during modeling and synthetic events. This can be accomplished by supplying a constant value based on the corresponding road event or enabling the system to respond to the inputs. Failure to do so may cause severe damage to the shock and/or vehicle.

4.3.15 Control Bandwidth. Leave real time data in the fore/aft load, vertical load, and vertical acceleration channels. Set the control bandwidth for these channels from 0.4 Hz to 40 Hz.

Note: If the lower edge of the band is set at 0.2 Hz, RPC Pro will not remove all of the low frequency content, and the rig will run out of stroke. However, the control bandwidth for the lateral channels should be 0.2 Hz to 40 Hz. This technique is only used for the compressed lateral files.

4.3.16 Filter Bandwidth. The data filter bandwidth for the lateral and camber moment channels should be 0 Hz to 40 Hz. The data filter bandwidth for all vertical and fore/aft channels should be 0.4 Hz to 40 Hz.

4.3.17 Control Scheme. The vertical direction control scheme is non-square (spindle acceleration and Wheel Force Transducer (WFT) load). The lateral control scheme is also non-square (lateral load and camber moment). Other control schemes may be required for certain vehicles to minimize body roll. Note that some suspension designs may require lateral load and camber moment peak loads and damages to be "balanced" (one "high", the other "low").

4.3.18 Test Development. Typical initial iteration gains are 0.4 for lateral and camber moment and 0.1 on all other channels. Be careful not to allow the drive to reach full scale in the lateral direction. The objective of the test development process for these schedules is to achieve the lateral and camber moment peak loading events, not the vertical and fore/aft events. The primary use of the vertical response data is to help control body roll and it has been found that a gain of 0.1 is sufficient to do this.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Not applicable.

5.3 Test Documentation. Not applicable.

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.

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7 Notes

7.1 Glossary. Not applicable.

7.2 Acronyms, Abbreviations, and Symbols.

C/M	Camber Moment
MR	Magneto Resistive
RLDA	Road Load Data Acquisition
RPC	Remote Parameter Control
RPC Pro	Remote Parameter Control Process
TH	Time History
WFT	Wheel Force Transducer

8 Coding System

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

Test to GMW15235

9 Release and Revisions

This standard was originated in March 2006. It was first approved by the Global Structural Durability Laboratory Expert Team in September 2008. It was first published in September 2008.

Issue	Publication Date	Description (Organization)
1	SEP 2008	Initial publication.
2	AUG 2013	Updated for 5 year refresh. (Global Structural Durability Laboratory Expert Team)

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Appendix A

Table A1: Channels Required for Test Development

Channel Description	Typical Simulation Transducer	Positive Direction Note 1
Left Front Vertical Force	WFT	Wheel Up
Right Front Vertical Force	WFT	Wheel Up
Left Front Vertical Spindle Acceleration	Accelerometer	Wheel Up
Right Front Vertical Spindle Acceleration	Accelerometer	Wheel Up
Left Front Lateral Force ^{Note 2}	WFT	Wheel Inboard
Right Front Lateral Force ^{Note 2}	WFT	Wheel Inboard
Left Front Camber Moment ^{Note 2}	WFT	Tire Patch Inboard
Right Front Camber Moment ^{Note 2}	WFT	Tire Patch Inboard
Left Front Fore/Aft Force	WFT	Wheel Aft
Right Front Fore/Aft Force	WFT	Wheel Forward
Left Rear Vertical Force	WFT	Wheel Up
Right Rear Vertical Force	WFT	Wheel Up
Left Rear Vertical Spindle Acceleration	Accelerometer	Wheel Up
Right Rear Vertical Spindle Acceleration	Accelerometer	Wheel Up
Left Rear Lateral Force ^{Note 2}	WFT	Wheel Inboard
Right Rear Lateral Force ^{Note 2}	WFT	Wheel Inboard
Left Rear Camber Moment ^{Note 2}	WFT	Tire Patch Inboard
Right Rear Camber Moment ^{Note 2}	WFT	Tire Patch Inboard
Left Rear Fore/Aft Force	WFT	Wheel Aft
Right Rear Fore/Aft Force	WFT	Wheel Forward
Engine Torque ^{Note 3}	Prop shaft Torque (RLDA - rear drive) Fixture Load Cell (Test Development - rear drive) Or Engine Mount Loads	Forward Vehicle Acceleration
Rear Axle Torque ^{Note 3}	WFT (RLDA - Sum of Rear Y-Moments) Fixture Load Cell (Test Development) Or Differential Mount Loads	Forward Vehicle Acceleration
Twist ^{Note 3}	Twist Transducer (framed vehicles) Stabilizer Bar Strains (non-framed vehicles)	Left Front Wheel Up

Note 1: Positive polarity is typical.**Note 2:** If WFTs are not available then ball joint (or other Remote Parameter Control (RPC) transducer) loads can be used.**Note 3:** Optional channels.

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