



Evasive Maneuver Stability Procedure

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 primary purpose of this procedure is to subjectively evaluate the vehicle's directional stability while executing aggressive lane change maneuvers relative to a benchmark vehicle.

1.2 Applicability. This test procedure applies to any two (2) axle pneumatic rubber tired vehicle at all load conditions.

1.3 Remarks. This test procedure describes a method for assessing vehicle direction control characteristics during aggressive lane change maneuvers that may occur during accident avoidance. The maneuver is primarily for subjective evaluation of vehicle directional control relative to a reference or benchmark vehicle. Vehicle steering, yaw, lateral acceleration, sideslip and body roll characteristics can be assessed. Instrumentation can optionally be installed to provide an objective assessment of these characteristics. This test is standard development work and should be used to assess the vehicle throughout the development process

2 References

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

2.1 External Standards/Specifications.

ISO 9001 ISO 15037-1 SAE J670E

2.2 GM Standards/Specifications.

GMW14264 GMW15307

2.3 Additional References.

Vehicle Technical Specification (VTS) Evasive Maneuver Stability and Performance (3.2.1.1.5.23) 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.

3.1.3 The test requires a uniform paved surface that is wide enough to provide two (2) lanes and appropriate run off to safely perform the maneuver. The road surface gradient shall not exceed 2.5%. The peak coefficient of friction of the road surface should be between 0.8 and 1.0.

3.1.4 Lane markings for a lane width of 3.5 m to 3.7 m are recommended and should be demarked by painted lines on the pavement or by traffic cones.

3.2 Equipment. As this procedure is primarily designed to subjectively assess vehicle performance while executing an evasive maneuver, no instrumentation is necessary other than:

3.2.1 Corrected Vehicle Speedometer. In the event that instrumentation is used to gain additional insight to vehicle performance, the following instrumentation may be considered.

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3.2.2 Data Acquisition System (DAS).

3.2.3 Instrumented steering wheel with steering wheel angle transducer.

3.2.4 Speed and Sideslip Transducer.

3.2.5 Roll Transducer.

3.2.6 Yaw Velocity Transducer.

3.2.7 Lateral Acceleration Transducer.

3.2.8 Longitudinal Acceleration Transducer.

3.2.9 Appropriate Cabling.

3.3 Test Vehicle/Test Piece. This test procedure applies to any two (2) axle, pneumatic rubber tired vehicle at all load conditions.

3.4 Test Time.

Calendar time: 0 days

Test time: 1 day

Coordination time: 1 day

3.5 Test Required Information.

3.5.1 (Optional): Channel Assignment and Full Scale Value:

- Steering Wheel Angle: 200 degrees.
- Vehicle Speed: 150 km/h.
- Vehicle Yaw Rate: 50 degrees.
- Vehicle Roll Rate: 10 degrees.
- Lateral Acceleration: 10 m/s².
- Longitudinal Acceleration: 10 m/s².
- Sideslip Angle: 40 degrees.

3.5.2 (Optional): Channels may be added as needed.

3.5.3 (Optional): If instrumentation is used, sample rate is 100 samples/s.

3.5.4 (Optional): If instrumentation is used, filter Frequency is 25 Hz.

3.6 Personnel/Skills. Operator must be qualified and documented as capable to run this test as required by ISO 9001 "Requirements for Quality Management Systems".

4 Procedure

4.1 Preparation.

4.1.1 Remove all loose equipment from the passenger compartment including tools, spare parts, extra transducers, and personal belongings.

4.1.2 (Optional): Instrumentation Installation.

4.1.2.1 The yaw velocity and lateral acceleration transducers are to be installed in the front passenger seat footwell in a level position. Record fore/aft location of the motion package relative to the front wheel centerline on the vehicle, lateral location relative to the vehicle centerline and vertical location relative to the ground in the Test Vehicle Description Sheet (TVD). Refer to Appendix A, Data Sheets A1 and A2 for a sample TVD.

4.1.2.2 The data acquisition computer must be fastened securely to the seat to prevent it from being dislodged in the event of unexpected loss of control.

4.1.3 Vehicle Preparation.

4.1.3.1 The test vehicle should be inspected to ensure that the proper tires and suspension components are installed, and that all chassis components are in operational condition.

4.1.3.2 Ballast the vehicle to the requested weight and weight distribution.

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Note: All equipment and ballast inside the passenger compartment of the vehicle must be securely held in place. External ballast must be contained in a ballast box, and a metal retaining screen installed between the cargo compartment and the passenger cab.

4.1.3.3 The fuel tank should be topped off and the vehicle test weights determined.

4.1.3.4 Outriggers should only be considered for high profile, early mule vehicles that may have questionable vehicle durability.

4.1.4 Tire Preparation.

4.1.4.1 Tire pressures should be set to the manufacturer's recommended cold pressure unless otherwise stated on the test request.

4.1.4.2 If run-flat tires are being evaluated at zero inflation pressure (hereinafter, 0 psi), the Schrader valve core should be removed to ensure the tire remains at 0 psi inflation pressure.

4.1.4.3 Condition of the Tires. New tires should be conditioned by driving 10 km at 100 km/h, including moderate cornering (0.5g) and several heavy brake stops (no locked wheels). Obviously, worn tires should be noted and appropriate wear state checked on the TVD. Run-flat tires need to be conditioned following the procedure found in Appendix B: Evaluating Handling Stability with Run-Flat Tires at Zero Inflation Pressure.

4.1.5 Operator Precautions.

4.1.5.1 Helmet and seat belts must be worn during the test in accordance with the regulations of the test facility.

4.1.5.2 The test operator must inform the testers using the facility of his presence using the mobile phone or radio system in accordance with the regulations of the test facility.

4.1.6 Additional information regarding industry standard Vehicle Dynamics test methods and terminology may be found in SAE J670E "Vehicle Dynamics Terminology" and ISO 15037-1 "Vehicle Dynamics Test Methods for Road Vehicles" respectively.

4.2 Conditions.

4.2.1 Environmental Conditions. The test is normally run on dry clean asphalt surfaces that are clear of debris. Wet surfaces may be specified in special cases.

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 During development, the vehicle can be tested under the conditions of interest. For Vehicle Technical Specification (VTS) validation, the vehicle is to be tested under the conditions stated in the Evasive Maneuver Stability VTS Template (shown in Appendix C).

- Load: Driver + Equipment.
- Load: Gross Vehicle Weight Rating (GVWR)/Gross Axle Weight Rating Rear (GAWR RR).
- Load: GVWR/GAWR RR w/Spare/Run-Flat at 0 psi ^{Note} – Outside and Inside Rear.
- Load: Gross Combined Weight Rating (GCWR).
- Load: Gross Combined Weight Rating (GCWR) w/Spare/Run-Flat at 0 psi ^{Note} – Outside and Inside Rear.

Note: See Appendix B for Evaluating Run-Flat tires at 0 psi

During development, the vehicle can be tested with and without Electronic Stability Control (ESC) activated. For VTS validation, the vehicle is to be tested with ESC active if the vehicle is equipped with ESC.

4.3 Instructions.

4.3.1 (Optional): Turn on instrumentation and data acquisition equipment. Allow 5 minutes for equipment to warm up.

4.3.2 (Optional): Stop the vehicle on the test road with the instrumentation and data acquisition running. With front wheels straight ahead and hands off steering wheel, balance the DAS.

4.3.3 Typical maximum vehicle speeds for completing the maneuver are 80 km/h to 110 km/h (50 mph to 70 mph). Safe execution of the maneuver is best accomplished by completing the maneuver at a lower speed and gradually increasing the speed and aggressiveness of maneuver on subsequent attempts to become familiar with the test vehicle at high "g" levels.

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4.3.4 Approach the course at the test speed, making single lane changes of various steering input aggression levels. Steering rate and steering amplitude should cause the vehicle response to be at the limit of vehicle directional control at very large sideslip angles.

4.3.5 Continue evaluations by making double lane changes of various steering input and aggression levels in the same manner as described in 4.3.4.

4.3.6 Assess the vehicle response with respect to the benchmark vehicle using the rating scale described in GMW14264. The vehicle response can be broken into three (3) phases:

- The initial turn.
- The secondary turn.
- Recovery of control.

Pay particular attention to (but not limited to) the following vehicle response characteristics during these phases:

- Steering response and feedback.
- Lateral motion.
- Yaw dynamics.
- Roll dynamics.
- Progressive sideslip.

4.3.7 Conduct as many runs at this test speed as needed to get a feel for the vehicle's response.

4.3.8 Repeat steps 4.3.3 thru 4.3.7 for each of the speeds required.

4.3.9 Repeat steps 4.3.3 thru 4.3.8 for the benchmark vehicle.

4.3.10 Complete the subjective evaluation form. A sample is shown in Appendix D.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Not applicable.

5.3 Test Documentation.

5.3.1 Data Preparation. Make sure the subjective evaluation form is complete. All required information should be recorded on the Test Vehicle Description (TVD).

5.3.2 (Optional): If objective data was measured, the data stored on the DAS should be uploaded to the appropriate network data storage location for processing using documented procedures and the data filenames specified on the test request sheet.

5.3.3 (Optional): Inform assigned engineer when the objective data file is loaded. Be prepared to provide a full vehicle description at this time. This should include the following:

- Vehicle description and number.
- Vehicle option content.
- Wheelbase and track.
- Steering wheel diameter.
- Location (x, y, z) of the inertial transducers.
- Tire brand, size, and pressures.

5.3.3.1 Channel Assignments and Scaling if Different from Standard.

- First and last calibration segment numbers.
- Total number of segments.
- Test loads.
- Test date, time, and operator.
- Data filename.

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