



Simulated Highway Off-Ramp 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 a maneuver similar to a highway off-ramp 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 on simulated highway off-ramp, a constant radius arc approached on a straight path that is tangent to the arc. The maneuver is primarily for subjective evaluation of steady state handling stability. The subjective assessment is relative to a benchmark vehicle and is described as a difference in a subjective rating (defined by GMW14264) relative to a reference or benchmark vehicle. Vehicle turn-in, dropped throttle, and braking in a turn characteristics can be assessed. Instrumentation can optionally be installed to provide an objective assessment of these characteristics. This test is standard development work. It should be used to assess the vehicle throughout development.

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), Simulated Highway Off-Ramp Stability and Performance (3.2.1.1.5.21) 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. The gradient shall not exceed 2.5%. The peak coefficient of friction of the road surface should be between 0.8 and 1.0. Wet surfaces may be specified in special cases.

3.1.4 The path for the test vehicle should be demarked by a painted line on the pavement or traffic cones.

3.1.5 The path is defined by a constant radius between 90 m and 167 m (larger radii are preferred). The arc duration should be between 90 degrees and 180 degrees. The radius used in the GM Vehicle Dynamics Test Area global template is approximately 134 m. The approach to maneuver is defined to be tangent to the circular path. A sample illustration is shown in Appendix A.

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3.2 Equipment. As this procedure is primarily designed to subjectively assess vehicle performance while executing a simulated off-ramp, 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.

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 hour

Coordination time: 0 hours

3.5 Test Required Information.

3.5.1 (Optional) Channel Assignment and Full Scale Value:

- Steering Wheel Angle: 100 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: 15 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 the fore/aft location of the motion package relative to the front wheel centerline on the vehicle, the lateral location relative to the vehicle centerline, and the vertical location relative to the ground in the Test Vehicle Description Sheet (TVD). Refer to Appendix B, Data Sheets B1 and B2 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.

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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.

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 C: 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. This procedure 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 Simulated Highway Off-Ramp Stability VTS Template (shown in Appendix D):

- Load: Driver + Equipment.
- Load: Gross Vehicle Weight Rating (GVWR)/Gross Rear 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 C for Evaluating Run-Flat tires at 0 psi

4.2.2.2 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 data acquisition system.

4.3.3 Bring vehicle to the speed required to generate 0.2g (or the prescribed "g" level of interest for the VTS) on the prescribed radius ± 2 km/h. Speed should remain constant for the initial portion of the evaluation.

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4.3.4 Approach the course at the test speed, aligning the vehicle to follow the marked path. Place the inside tire just outside the cone or line marking the path. The entry should be tangent to the circular path.

4.3.5 Turn In. At the end of the approach, turn the steering wheel to follow the circular path. Different steering input rates can be assessed on subsequent runs.

4.3.6 Assess the turn in characteristics of the vehicle, especially stability. Examples of these characteristics may include the turn in stability (how quickly does the vehicle response reach steady state cornering and how much does the driver have to correct the steering input to maintain directional control), the time delay between steering input and vehicle response, the ratio of vehicle response to steering input, is the vehicle predictable or does it change character suddenly, and the steering torque required to turn in.

4.3.7 Steady State Cornering. After turn in, maintain the circular path and test speed.

4.3.8 Assess the steady state cornering characteristics of the vehicle, especially stability. The threshold point for stability may be considered to be when the driver focus shifts from maintaining path to maintaining directional control. Examples of these characteristics may include how easy is it to induce rear end breakaway with perturbations to the steering inputs, the steering torque required to maintain steady state cornering, and the ability to negotiate the turn at higher lateral accelerations (grip).

4.3.9 Drop-Throttle. After 3 s to 5 s of steady state cornering, quickly release your foot from the accelerator. If there is not sufficient room to conduct this evaluation in one pass, run an additional pass. This evaluation may have to be conducted elsewhere if it is not possible to complete this maneuver at the test site.

4.3.10 Assess the drop throttle characteristics of the vehicle, especially stability. Examples of these characteristics may include how easy is it to induce rear end breakaway with perturbations of the steering/throttle inputs, how abrupt is the change in yaw when the vehicle breaks away, how much does the driver have to work to maintain directional control, is the vehicle consistent (predictable) or does it change character suddenly.

4.3.11 Braking in a Turn. After 3 s to 5 s of steady state cornering, use the brakes to achieve deceleration while cornering. A number of runs may be run to examine the effect of different levels of deceleration on cornering. If there is not sufficient room to conduct this evaluation in one pass, run an additional pass. This evaluation may have to be conducted elsewhere if it is not possible to complete this maneuver at the test site.

4.3.12 Assess the braking in a turn characteristics of the vehicle, especially stability. Examples of these characteristics may include how easy is it to induce rear end breakaway with perturbations of the steering/brake inputs, how abrupt is the change in yaw when the vehicle breaks away, how much does the driver have to work to maintain directional control, is the vehicle consistent (predictable) or does it change character suddenly.

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

4.3.14 Repeat steps 4.3.3 thru 4.3.13 for each of the speeds required. Maximum steady state lateral acceleration occurs at the speed where the vehicle can no longer maintain the prescribed path.

4.3.15 Repeat steps 4.1 thru 4.3.14 for the benchmark vehicle.

4.3.16 Complete the subjective evaluation form. A sample is shown in Appendix E.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Not applicable.

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

5.3.1 (Optional): If objective data was measured, the data stored on the data acquisition system 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.

5.3.2 (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.

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