Constant Radius Constant Speed

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 test procedure describes a method for the following steady-state vehicle handling properties: Front and rear cornering compliances, total vehicle understeer and roll gradient. The steering wheel rim force gradient, or simply the steering force gradient, is also measured. Additionally, lateral acceleration response time, steering sensitivity and overall steering ratio can be estimated from this test. For tests with trailers, the trailer axle assembly cornering compliance can also be calculated.

1.2 Applicability. This test procedure can be applied to all pneumatic rubber-tired highway vehicles with hand wheel steering control at any load condition.

1.3 Remarks. This test procedure is GM's interpretation of the Constant-Radius test method described in ISO 4138.

2 References

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

2.1 External Standards/Specifications.

ASTM E1136	ASTM E1137-90	ISO 4138	ISO 9001

2.2 GM Standards/Specifications.

None

2.3 Additional References. None.

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 This test is to be run on a smooth, flat and dry surface with a high friction coefficient. Unless otherwise specified, the road test surface should produce a Peak Friction Coefficient (PFC) of 0.9 or greater when measured using an ASTM E1136 standard reference test tire, in accordance with ASTM E1137-90, Method E, at a speed of 64.4 km/h (40 mph) without water delivery.

3.1.4 This test procedure requires a test area approximately 150 m in radius. The nominal radius for actual test execution is 100 m. The test may be run on a radius of less than 100 m, however, the resulting data should not be stored to the handling laboratory database for test radii less than 80 m.

3.1.5 The lateral gradient of the test surface should not exceed 2.5%.

3.2 Equipment.

3.2.1 Steering Wheel Angle Transducer.

3.2.2 Steering Wheel Torque Transducer.

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3.2.3 Vehicle Speed Sensor. Vehicle velocity and side slip is typically measured with GPS/inertial sensors (like Oxford Technologies RT3000 series). Alternatively, vehicle velocity and sideslip can also be measured with an optical sensor placed at the front- or rear-center of the vehicle, or radar based sensors, or sonar based sensors. Sensor outputs are transmitted simultaneously to the data acquisition system and the instrument panel mounted display. This instrument panel display allows the driver to accurately monitor vehicle speed.

3.2.4 Multi-Axis Inertial Sensor. A multi-axis inertial sensing system is used to measure fore/aft and lateral accelerations and yaw rates (e.g., Oxford Technologies RT3000 series). The position of the multi-axis inertial sensing system must be accurately measured relative to the total vehicle center of gravity (CG) or centroid of the vehicle in its test configuration. These data points are required to translate the motion of the vehicle at the measured location to that which occurred at the actual centroid, to remove roll, pitch and yaw effects. Alternatively, a motion box package may be used to measure lateral and fore/aft accelerations and yaw rate.

3.2.5 Roll Height Sensors. Height sensors are used to measure left and right side vertical displacements for the calculation of vehicle roll angle by using one (1) ultrasonic or laser ranging module mounted on each side of a vehicle. With these data points, roll angle is calculated during post processing using trigonometry.

3.2.6 Trailer Articulation Angle Sensor. For tests with a trailer, a trailer articulation angle sensor is installed over the hitch ball to measure the relative angle between the longitudinal axes of the vehicle and trailer.

3.2.7 Data Acquisition System (DAS). See 4.2.4 Data Collection for more information about the data acquisition methodology.

3.3 Test Vehicle/Test Piece. The test vehicle must represent the desired test condition. All operating components likely to influence the test results, especially the steering system, shall be in proper operating condition.

3.4 Test Time.

Calendar time:	0 days
Test hours:	1 to 2 hours
Coordination hours:	1 to 2 hours

3.5 Test Required Information.

3.5.1 DAS Channels and Full Scale Values. See Table 1

Table 1: DAS Channels and Full Scale Values

Channel	Value
Steering Wheel Angle	1440 degrees
Steering Wheel Torque	40 Nm
Vehicle Speed	150 km/h (93.2 mph)
Vehicle Sideslip	10 degrees
Lateral Acceleration	10 m/s^2
Yaw Velocity (Rate)	10 degrees/s
Roll Angle	10 degrees
Trailer Articulation Angle (if applicable)	20 degrees

3.5.2 Additional Channels. May be used as required.

3.5.3 Sample Rate. All data is to be sampled at 100 Hz. Typical anti-aliasing 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.

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4 Procedure

4.1 Preparation.

4.1.1 Installation.

4.1.1.1 The DAS must be well restrained inside the vehicle. The front passenger seat is a typical and acceptable location.

4.1.1.2 The multi-axis inertial sensor must be installed and securely mounted at or near the centroid, with the location recorded on the Test Vehicle Description (TVD) worksheet. See Appendix B, Data Sheets B1 and B2 for a sample TVD worksheet. The CG of a vehicle is typically located in the area between the front driver and passenger seats. Interior components such as the center console may need to be removed in order to mount the multi-axis inertial sensor in a suitable location.

Note: All data gathered, via the sample TVD worksheets or similar methodology, will be subsequently uploaded to the Vehicle Handling Test Resource Information Management System (VHTRIMS) database.

4.1.1.3 The roll height sensors must be securely mounted on the left and right side of the vehicle. Typically, the sensors are installed at the end of a bar than can be strapped securely to the front of the vehicle. The fore/aft location of the sensors and the lateral distance between the sensor heads should be recorded on the TVD worksheet.

4.1.1.4 If an optical speed sensor is used, it should be mounted at the lateral center of the vehicle. If the sensor cannot be mounted at the precise lateral center of the vehicle, the magnitude and direction of offset from center should be documented and reported to the appropriate test engineer.

4.1.1.5 If a motion box package is used, it should be installed in a level position as close to the centroid as is practical. The front passenger seat foot well is a typical and acceptable location. The fore/aft location of the motion package should be recorded on the TVD worksheet.

4.1.1.6 All ballast inside the passenger compartment of the vehicle must be secured in place. Water dummies must be secured with straps in addition to the seat belts. All loose equipment should be removed from the passenger compartment, including tools, extra transducers and personal belongings.

4.1.2 Vehicle Preparation.

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

4.1.2.2 The vehicle suspension should be aligned to nominal specifications.

4.1.2.3 With the fuel tank full, the vehicle test weights should be determined and recorded.

4.1.2.4 Vehicles equipped with a “tilt-wheel” steering column should be adjusted such that the position of the column is as straight as possible.

4.1.3 Tire Preparation.

4.1.3.1 Tire pressures should be set to the requesting engineer’s recommended cold pressure for each tire, unless otherwise stated on the test request.

4.1.3.2 Note the Condition of the Tires. New tires should be broken in by driving 10 km at 100 km/h, including moderate cornering and several heavy brake stops (without inducing skidding). Obviously worn tires should be noted and the appropriate wear state checked on the TVD worksheet.

4.1.4 Operator Precautions.

4.1.4.1 Seat belts must be worn during testing. Lock all doors and close all windows prior to testing.

4.1.4.2 The test operator (driver) must inform any others at the test site of their presence using the appropriate site-specific communications protocol.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 The test is run on a dry, clean asphalt surface that is clear of debris.

4.2.1.2 The ambient air temperature should be above 0 °C (32 °F) and below 40 °C (104 °F).

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.

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