Straight Line Braking Yaw Response

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. To objectively determine the brake induced yaw response of a vehicle under moderate and extreme Antilock Brake System (ABS) active braking conditions.

1.2 Applicability. The constant deceleration portion of the test is applicable at all permissible loading conditions to all passenger cars and light trucks up to 3500 kg Gross Vehicle Mass (GVM). The maximum deceleration portion of the test is applicable at all permissible loading conditions to passenger cars and light trucks up to 3500 kg GVM equipped with four-wheel antilock brake systems. Trucks with GVM greater than 3500 kg may use this procedure, but reduced test speeds may be necessary.

1.3 Remarks. This procedure is intended to quantify the conditions commonly referred to as brake pull or lead, and directional instability caused by braking. The test procedure is designed to quantify the directional response of the vehicle to inputs from the foundation brakes and antilock brake system with no steering input. The procedure has two sections:

- The constant deceleration test used for foundation brake evaluation and,
- The maximum deceleration test for ABS-equipped vehicles.

2 References

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

2.1 External Standards/Specifications.

FMVSS 135

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- Subsystem Technical Specification (SSTS) for Brake Controls
- Vehicle Technical Specification (VTS)

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 To be conducted on flat, level surfaces (less than 1% grade in any direction) with adequate length and lateral runoff to allow fixed control braking. Surface friction characteristics should be known to allow comparisons between vehicles and test sites.

3.1.4 Vehicle weighing station providing measurements of at least the front and rear axle; ballast.

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3.2 Equipment.

3.2.1 Speed measurement device and readout. The speed transducer must be capable of reading velocity in excess of the vehicle test speed, a minimum of 150 km/h is recommended. The transducer accuracy must be within 0.5 km/h over the speed range of 5 km/h to 150 km/h.

3.2.2 Accelerometer oriented to measure longitudinal acceleration. The accelerometer must be capable of measuring a minimum of 1.2 m/s^2, with an accuracy of 0.01 m/s^2.

3.2.3 Angular rate sensor oriented to measure yaw velocity. The angular rate transducer must be capable of measuring at ± 50 degrees/s with an accuracy of 0.05 degrees/s.

3.2.4 Steering wheel constraint or locking device.

3.2.5 Driver readable deceleration indicator.

3.2.6 Brake application indicator or pedal force transducer.

3.2.7 Digital data acquisition system (DAS). Scan data at a sample rate of 100 Hz.

3.2.8 Appropriate signal conditioning equipment and cabling.

3.2.9 Thermocouples to measure pad/lining temperatures (optional).

Note: All instrumentation is to be calibrated as required. Record instrumentation details and calibration dates in the test record.

3.3 Test Vehicle/Test Piece. The specific vehicle chosen for testing should be representative of the vehicle population with respect to brake system, tire, suspension, and mass distribution properties. Extreme cases of the preceding parameters should also be addressed.

3.4 Test Time. The following times are approximate. The test surface conditions, ambient weather conditions, and the selected conditioning schedules for the brake system and tires will all affect the timing of the test.

Calendar time:	2 d to 4 d
Test time:	8 h to 16 h
Coordination time:	16 h

3.5 Test Required Information.

3.5.1 This procedure may be run as part of a series of Combined Cornering and Braking tests. This test may be used for system development or for system validation of requirements in the VTS or Brake Controls SSTS.

3.5.2 Brake corner parts should be in newly burnished or burnished condition at start of test for all Tier 2 and VTS/SSTS validation testing. Development testing should have the condition of the brake parts specified in the work order.

3.5.3 Tires for Tier 2 and VTS/SSTS validation testing should be in new burnished condition at start of test. Development testing should have the tire condition specified in the work order.

3.6 Personnel/Skills. An experienced brake/vehicle dynamics test technician is required to perform vehicle and instrumentation and conduct the test.

4 Procedure

4.1 Preparation.

4.1.1 The vehicle to be tested must be in safe operating condition for maneuvering levels approaching the limit of vehicle performance. Condition of tire, brake and suspension components should be inspected carefully. All vehicle safety equipment must be in proper operating condition.

4.1.2 Vehicles with obviously high centers of gravity must be reviewed for roll stability, and maneuvers limited or safety equipment added as appropriate.

Note: When this procedure is being run as part of a matrix of Combined Cornering and Braking tests, the same burnished brake hardware may be used throughout the test matrix. Also, the same tires may be used throughout the matrix as long as flat spotting of the tires does not occur.

4.1.3 Brake components shall be prepared as specified by the request engineer. The following brake burnish schedules are recommended.

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4.1.3.1 For validation testing, perform a 200 stop brake burnish following instructions in FMVSS 135. This burnish requires the installation of a minimum of one (1) thermocouple in one (1) front brake pad. Install the test tires on the vehicle for the brake burnish.

4.1.3.2 For development testing, in the absence of other instruction, perform a 200 stop brake burnish following instructions in FMVSS 135. If a short brake burnish is needed, a recommended short brake burnish schedule is 50 brake snubs from 96 km/h to 64 km/h at 1.6 km intervals. Install the test tires on the vehicle for any brake burnish.

4.1.4 Tires and tire conditioning shall be specified by the request engineer. The following tire conditioning schedule is recommended for validation testing. If the test tires are base all-season tire (ALS) or of a relatively soft rubber compound, monitor tire tread wear after every two (2) stops of the tire burnish. Use judgment to end the tire burnish before any tread degradation.

4.1.4.1 Install new tires on vehicle and run the brake burnish.

4.1.4.2 Following the brake burnish, perform ten (10) ABS or deceleration threshold stops from 100 km/h on high coefficient of friction surface at 1.6 km intervals.

4.1.4.3 Rotate tires front to rear. If front and rear tires are different sizes, do not rotate tires.

4.1.4.4 Perform a second set of ten (10) ABS or deceleration threshold stops from 100 km/h on high coefficient of friction surface at 1.6 km intervals.

4.1.5 Install transducers, DAS, driver readouts and steering control equipment. Accelerometers should be mounted as near the center of gravity as possible. If the speed measurement device is vehicle mounted, attach device as close to vehicle centerline as possible.

4.1.6 Calibrate instrumentation as necessary.

4.1.7 Load vehicle to test configuration. Curb plus driver plus instrumentation plus full fuel load plus any required safety equipment loading is recommended. Other loading conditions may be specified by request engineer. All ballast must be properly secured. Note vehicle test weight in the test record.

4.1.8 Inflate cold tires to manufacturer's recommended pressure or per test engineer's instructions. Tire pressures should be monitored periodically throughout the testing. Adjust pressures when necessary, taking into account the normal pressure variation with both tire and ambient temperatures.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Ambient Temperature. For development testing, the ambient temperature during testing is not restricted. For validation testing, an ambient temperature between -10 °C and +40 °C during testing is recommended.

4.2.1.2 Wind Conditions. The recommended sustained wind speed limit for testing is 24 km/h. Use judgment when testing during wind gust conditions up to 32 km/h. The recommendation is to suspend testing, if wind gusts are over 32 km/h.

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 Test surfaces should be free of debris. Low coefficient surface should be kept wet, as appropriate, during the testing.

4.2.2.2 Recommended test speeds for the test surfaces are compiled in Table 1. Other speeds may be specified to suit the vehicle and surface combination depending on facility, vehicle, or safety constraints.

Table 1: Recommended Test Speeds

Surface	Recommended Test Speed
Dry Asphalt or Concrete or equivalent (High coefficient > 0.8)	100 km/h
Wet Jennite, Tile, Smooth Concrete or similar surfaces (Low coefficient < 0.6)	50 km/h

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