



Brake Pedal Dynamic Vertical Offset Measurement

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 evaluate the dynamic characteristics of the brake system and throttle system in vehicles with automatic transmission with respect to simultaneous application of pedals.

1.2 Applicability. Passenger vehicles, multipurpose vehicle, and light-duty trucks equipped with automatic transmissions.

1.3 Remarks. This test measures the lateral separation, the static vertical offset, and the dynamic vertical offset of the test vehicle.

This test shall be used to validate the Dynamic Vertical Offset (DVO) requirement in the GM Vehicle Technical Specification (VTS) when a vehicle test is required.

This test may be used for development of the pedal assembly to maximize perceived pedal feel with respect to pedal placement while maintaining dynamic vertical offset compliance.

This test was developed to address sudden acceleration incidents occurring in the event of a pedal application error in which the driver's foot overlaps the brake and accelerator pedals. More information on sudden acceleration incidents is available in Appendix G of National Highway Traffic Safety Administration (NHTSA) Report No. DOT-HS-807-367.

GM Best Practice Brakes-84 for DVO and pedal separations contains additional information.

This procedure is for vehicles with automatic transmissions. DVO testing may not be required on vehicles equipped with pedal configurations where the minimum brake and accelerator pedals lateral separation is greater than 64 mm including build variation stack-up.

2 References

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

2.1 External Standards/Specifications.

DOT-HS-807-367 SAE J826

2.2 GM Standards/Specifications.

GMW15102 GMW15106

2.3 Additional References.

- Global Document Management System (GDM).
- GM Best Practice Brakes-84. The supplier shall work with the GM responsible engineer to comprehend this requirement.

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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 Test area shall be a level, smooth, surface with a peak coefficient of friction equivalent to dry asphalt.

3.1.4 The test area shall have sufficient clearance around the vehicle to allow for vehicle movement during testing. Pylons or some other means of segregating the test area may be necessary.

3.1.5 The polished concrete or painted concrete surface within a garage or laboratory area is not an acceptable test site since this surface peak friction coefficient is lower than that of dry asphalt.

3.2 Equipment.

3.2.1 Pedal Bridging Fixture. This fixture serves to provide simultaneous movement of the accelerator pedal and the brake pedal. When installed, the accelerator pedal displacement relative to the brake pedal should be adjustable by the driver. On General Motors North America bridging fixtures, the accelerator pedal applicator has been designed to conform to the silhouette of the foot on an SAE International (SAE) J826 50th percentile male mannequin. The intent of the fixture is to approximate an actual pedal bridging condition that a driver might experience. Use of an equivalent bridging fixture is acceptable. Appendix A, Figure A2 shows a sketch of a typical bridging fixture. See Appendix A, Figures A4 thru A8 for photographs of a typical pedal bridging fixture.

3.2.2 Pedal Force Transducer and Readout. The instrumentation used for this application should be capable of measuring and displaying brake pedal forces of 90 N, 180 N, and 270 N.

3.2.3 Brake Force Rod. This is a threaded rod with a bracket which mounts to the steering wheel and shall be used to apply constant force to the brake pedal via the pedal force transducer.

3.2.4 Brake Booster Vacuum Transducer. Brake booster vacuum transducer or gauge is required to record booster vacuum during the test. Vacuum levels are to be measured at the booster (not manifold vacuum). For other brake assist systems, consult request engineer for any needed measurement equipment.

3.2.5 Scan Tool. Various engine parameters may be requested for monitoring during each test. A vehicle diagnostic scan tool is an acceptable instrumentation.

3.2.6 Brake Burnish Instrumentation. Brake lining or pad thermocouples and temperature reading equipment may be required.

3.2.7 Calibration. Instrumentation identification and calibration dates should be listed in the test record unless otherwise preserved in the test laboratory records. All instrumentation must be calibrated as required.

3.3 Test Vehicle/Test Piece. Test vehicle shall be as specified by test engineer. Pedal assemblies and powertrain configurations should be production intent unless otherwise specified.

3.4 Test Time.

Calendar time: 2 days to 3 days

Test time: 4 hours to 8 hours

Coordination time: 2 hours to 4 hours

3.5 Test Required Information.

Caution: With the bridging fixture installed the driver may not be able to stop the vehicle. The bridging fixture inhibits the normal operation of the brake pedal. Turn the ignition off to stop the vehicle.

3.6 Personnel/Skills. A technician or engineer trained to perform the tasks in section 4 is required.

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4 Procedure

4.1 Preparation.

4.1.1 Vehicle Conditioning. Check the engine specifications if requested. Perform a functional check of brake system performance including brake switch adjustment. Check and, if necessary, correct to specification the engine coolant level, automatic transmission fluid level and tire pressure. Determine and include in the test record the maximum allowable transmission oil temperature and the design specifications for pedal lateral separation and static vertical offset. Test vehicle should be at lightly loaded vehicle weight for the DVO testing.

4.1.2 Brake Conditioning. The brake pads or shoes should be in a burnished condition unless otherwise specified. The recommended brake burnish is the GMW15102 burnish for a vehicle less than 4536 kg and the appropriate GMW15106 burnish for a vehicle equal to or greater than 4536 kg.

4.2 Conditions.

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.

4.2.2.1 Vehicles equipped with four-wheel drive, hydro-boost or equivalent brake systems, traction control, locking rear differential, etc., should be evaluated for their possible effects by the engineer requesting DVO testing. Engine load requirements affected by air conditioning use should also be considered. Vehicle should be tested with the highest available axle ratio unless otherwise specified.

4.2.2.2 Vehicles equipped with air conditioning (A/C) should be tested with the A/C off, unless otherwise specified. The requesting engineer should be aware of which A/C setting represents worst-case for the test vehicle.

4.3 Instructions.

4.3.1 Static Pedal Measurements. Measurement of static pedal geometry may be conducted at any time during the test sequence. The measurements will be made with the vehicle stationary and the engine off.

4.3.1.1 Measure the lateral separation between the accelerator pedal and brake pedal as shown in Appendix A, Figure A1. This measurement should be performed at the point of minimum separation. The lateral separation should be measured by making the accelerator and brake pedal coplanar if permitted by vehicle design. Compare measurement with design specification. If measurement is not within specification, stop test and consult requesting engineer. The measurements will be reported in millimeters, with an accuracy of ± 1 mm. Measurements should be made with the pedal covers in place.

4.3.1.2 Measure the static vertical offset as shown in Appendix A, Figure A1. This measurement is made without any load placed on either the brake or accelerator pedal. Compare measurement with design specification. If measurement is not within specification, stop test and consult requesting engineer. The measurements will be reported in millimeters, with an accuracy of ± 1 mm. Measurements should be made with the pedal covers in place.

4.3.2 Dynamic Vertical Offset Measurement.

4.3.2.1 Although not required, it is recommended that the following parameters be observed and/or recorded during each test:

- Engine speed.
- Throttle position sensor voltage, if available.
- Manifold absolute pressure.
- Engine coolant temperature.

4.3.2.2 Brake booster vacuum levels should be measured after the brake apply and before the onset of motion. For other brake assist systems, consult request engineer for any needed measurements.

4.3.2.3 Set vehicle to lightly loaded vehicle weight unless otherwise specified. Move vehicle to test area. Unless otherwise instructed, deplete the vacuum booster, turn off engine, and park vehicle for 8 h in ambient temperature/humidity conditions. The 8 h soak is recommended, but not mandatory. Record the soak time and the ambient conditions in the test record.

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4.3.2.4 At time of test, adjust the depth or extension of the accelerator pedal actuator of the bridging fixture so that it is completely retracted.

4.3.2.5 Position the pedal bridging apparatus over the brake pedal surface, and align the fixture so that the left edge of the foot plate just misses the right edge of the brake pedal. The fixture should also be aligned with the transverse centerline of the brake pedal. See Appendix A, Figure A2. Rigidly attach the bridging fixture to the brake pedal. Adapt the installation as needed to ensure rigid attachment on the pedal.

4.3.2.6 If, when installing the fixture per above, the foot plate will not contact the accelerator pedal, the test can be completed by sliding the pedal bridging apparatus toward the accelerator pedal until contact can be made. Note the special alignment in the test record and notify the requesting engineer of the condition.

4.3.2.7 Attach the brake pedal force transducer to the pedal bridging apparatus. Install and connect the associated signal conditioning and display device(s). Adjust or calibrate the zero and range of the pedal force transducer.

4.3.2.8 The suggested DVO testing schedule is shown in Table 1. Tests in this schedule are conducted at 90 N, 180 N, and 270 N of brake pedal force, in both Drive and Reverse gears. The measurements will be reported in millimeters, with an accuracy of ± 2 mm. If using the suggested test schedule, the test sequence may be terminated, if desired, when two (2) consecutive tests result in an end of test condition other than Motion. For vacuum brake booster systems, the booster vacuum should be bled down by repeatedly pumping the brake pedal to deplete stored vacuum prior to the start of each DVO test. Appendix A, Data Sheet A1 shows a sample data sheet.

Table 1: Dynamic Vertical Offset Test Schedule

Test Sequence Number	Brake Pedal Force (N)	Transmission Gear	Test Conditions
Cold			
1	90	Drive	Cold vehicle. 8 h cold soak or as specified.
2	90	Reverse	Continue from test 1.
Hot			
3	90	Drive	For tests 3 thru 8, the engine should be operating with a minimum coolant temperature of 80 °C.
4	90	Reverse	
5	180	Drive	
6	180	Reverse	
7	270	Drive	
8	270	Reverse	

4.3.2.9 With vehicle at the test area, set park brake. Start the engine without depressing the accelerator pedal and shift the transmission into the desired gear. Allow brake booster vacuum to stabilize before beginning the test.

4.3.2.10 The tester will begin by applying the desired pedal force of 90 N, 180 N, or 270 N via the brake force rod.

4.3.2.11 Release the park brake.

4.3.2.12 Reset brake pedal force, if necessary.

4.3.2.13 Begin extending the accelerator pedal actuator downward by rotating the adjuster. This action should result in an increase in engine speed.

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