



Tire Snow Driving Traction

1 Scope

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 determine the driving traction performance of a light vehicle tire under specific test conditions, typically on a specially prepared snow covered surface.

1.2 Foreword. This test utilizes a four wheel, rear-wheel drive test vehicle with a specially instrumented axle to measure the fore-aft and vertical forces of a driven tire. Test wheel speed and vehicle speed are also measured. This procedure is used primarily for determining the driving traction performance of a tire relative to a specified control tire or to other tires tested under similar test conditions. The procedure and equipment are intended for testing on snow covered surfaces, but can be extended by the user to other low coefficient surfaces.

1.3 Applicability. This procedure applies to passenger car, light truck, and light vehicle commercial tires.

2 References

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

2.1 External Standards/Specifications.

ASTM D2240

ASTM F377

ASTM F457

ASTM F1805

ASTM E1136

2.2 GM Standards/Specifications.

GMW16590

3 Resources

3.1 Facilities.

3.1.1 Standard GM Snow Test Surface (Medium Pack Snow per ASTM F1805). For snow traction testing, standard surface conditions required are 25 mm to 50 mm of medium-packed snow over a hard-packed base. The test surfaces are to be maintained or groomed daily or as needed to achieve the desired snow depth and uniformity. See Appendix A for details on General Motors snow course preparation techniques and procedures.

3.2 Equipment.

3.2.1 Test Equipment. Test equipment is typically a specially fabricated and instrumented vehicle measuring the fore-aft and vertical forces at the tire/test surface interface, speed of the driven test wheel, and the test speed of the moving vehicle. Vehicle size and selection depends on the tire size and loading conditions to be tested. The vehicle shall have the capability of maintaining a specified test vehicle speed to within ± 0.8 km/h, through all levels of applied driving torque. Vehicle speed is maintained by braking the non-test wheels while applying increasing torque to the test wheel. See ASTM F1805 for additional detail on the test equipment.

3.2.2 Calibration Instrumentation.

3.2.2.1 The equipment used to calibrate the test equipment's force transducer shall conform to the requirements of ASTM F377. Positioning of the transducer is important to the test results generated with this procedure, see Appendix A, Section A2 for further explanation of the alignment effects on the data.

GM Confidential

© Copyright 2013 General Motors Company All Rights Reserved

November 2013

Page 1 of 11

3.2.2.2 The equipment used to calibrate the test equipment speed transducers shall conform to ASTM F457.

3.2.3 Test System Instrumentation.

3.2.3.1 The test system measuring instrumentation should have specifications sufficient to meet filtering and digital requirements as outlined in ASTM F1805.

3.2.3.2 If the data is to be filtered, a low pass filter with a cutoff frequency greater than 18 Hz, filter must be used, and all channels must be filtered in the same manner to prevent phase lag between the recorded channels.

3.2.3.3 A force transducer to measure the longitudinal and vertical forces acting upon the test tire.

3.2.3.4 A vehicle speed sensor to accurately determine vehicle test speed. This may be accomplished with a speed pickup from a front wheel of the test vehicle, a fifth wheel, or some other appropriate device.

3.2.3.5 An encoder, or some other appropriate device, to measure angular velocity of the test position wheel.

3.2.3.6 A data recorder, to provide a permanent record of transducer output signals prior to any data processing.

3.2.3.7 Calibrated thermometers or other temperature measuring devices used to measure tire, snow and ambient temperatures.

3.3 Test Vehicle/Test Piece.

3.3.1 Control Tire. ASTM E1136 Standard Reference Test Tire.

3.3.2 Test Tires. Test pieces provided by requestor.

3.4 Test Time. Not applicable.

3.5 Test Required Information. All required test information is provided through a test request entered into Global Tire-Wheel Test System (GTWTS).

3.6 Personnel/Skills. Not applicable.

4 Procedure

This GM Snow Traction Test Procedure generally follows the ASTM F1805 (Option 1). If there are discrepancies between this document and ASTM F1805 (Option 1), then this document is to take precedence.

4.1 Preparation.

4.1.1 Test tires should be approximately of the same age and shall have been stored at the same environmental conditions prior to testing. The test tires shall also be thermally equilibrated to the ambient conditions existing at the time of testing. The tires shall be shaded to eliminate solar loading to alter their thermal state prior to testing.

4.1.2 All transducers and instrumentation shall be calibrated according to ASTM F377 and ASTM F457. Transducers and the data recording system are to be powered for a sufficient period of time prior to testing insuring thermal transients do not exist.

4.1.3 The test vehicle's front tires should be the same size and have the inflation pressures within ± 3.5 kPa of that as used during the calibration, to maintain a constant front axle height and effective rolling radius for speed calibration.

4.1.4 Mount the test and control tires on appropriate rims as requested. The ASTM E1136 control tire shall be mounted on a 152.4 mm (6.0 in) width rim.

4.1.4.1 Select a wheel with the proper amount of offset, or back spacing, to minimize the effects of possible transducer offset sensitivity.

4.1.4.2 For directional tires, insure the tire rotation will be consistent with the sidewall markings.

4.1.4.3 When possible, it is preferred to have the intended outboard sidewall mounted facing out on the test vehicle for consistency. The intended outboard sidewall is generally identifiable by decorations (white sidewall, serrations, raised white letters, etc.) or a full Department of Transportation (DOT) Tire Identification Number (TIN) if there are both a full and partial TIN present.

4.1.5 Control tires shall not be greater than 12 months old when tested.

4.1.6 Test tires should be less than 6 months old when tested.

GM Confidential

© Copyright 2013 General Motors Company All Rights Reserved

November 2013

Page 2 of 11

4.1.7 Test and control tires shall not have force or run-out grind corrections.

4.1.8 Tread labels should be removed along with any residual adhesives used to affix labels.

4.1.9 Mold vents and flashing protuberances are to be trimmed away from tire tread and upper sidewall surfaces of test and control tires. The tires are to be smooth in the trimmed areas and appear as if the tires were molded without vents and flashing.

4.1.10 Break-in, distance accumulation on a vehicle, is not required unless specified or necessary to smooth the trimmed areas where mold vents and flashing were present.

4.1.11 Measure and record the Shore A durometer of all test and control tires according to ASTM D2240.

4.2 Conditions.

4.2.1 Environmental Conditions.

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 The test loads and inflation pressures are to match those requested. Standard test conditions are provided by tire type in Table 1. However, for special cases, the requester may deviate from those standard conditions.

Table 1: Test Conditions by Tire Type

Tire Type	Load	Inflation Pressure
Control Tire (ASTM E1136)	4586 N	240 kPa
Passenger Car (T&RA and European Tire and Rim Technical Organization (ETRTO))	70% Maximum Load Capacity or 5560 N, whichever is less	250 kPa
Light Truck (T&RA) and Commercial (ETRTO)	70% Maximum Load Capacity or 5560 N, whichever is less	350 kPa

4.3 Instructions.

4.3.1 Test tires and control tires are to be run in an alternating pattern for every test sequence. The test sequence must begin with a control tire, then the control tire is repeated as every third test, and the sequence must end with a control tire. An example sequence would be C₁, T₁, T₂, C₂, T₃, T₄, C₃, T₅, T₆, C₄ where C and T represents control tires and test tires, respectively (see Appendix A, Section A3). A single test tire or control tire may be used repeatedly as long as the tread surface maintains a new appearance. Each test tire shall be tested at least three (3) times, preferably on different days.

4.3.2 At a minimum, perform a resistive shunt calibration on the force transducers at the beginning and end of each test sequence.

4.3.3 Install the test tire on the test vehicle.

4.3.4 A tire with a similar loaded radius shall be installed on the non-test side of the vehicle to level the axle across the vehicle. This non-test tire shall have an outside diameter within 25 mm of the test tire outside diameter. This non-test tire shall be equipped with a tire chain or other traction enhancement to prevent the loss of tractive ability during the test.

4.3.5 Adjust the static load on the test tire within ± 20 N of the test load specified in Table 1.

4.3.6 Set the inflation pressure of the test tire to within ± 3.5 kPa of the inflation pressure specified in Table 1 immediately before testing.

4.3.7 Level the axle mounted load cell to eliminate cross-talk between the vertical and longitudinal force channels. This is typically done by adjusting the vehicle ride height to a predetermined set point on an adjustable height suspension. See Appendix A, Section A2 for discussion of the implications associated with transducer leveling with respect to the gravitational force.

GM Confidential

© Copyright 2013 General Motors Company All Rights Reserved

November 2013

Page 3 of 11

4.3.8 Record test tire identification.

4.3.9 Record other test data, including but not limited to, the test date and time, ambient and test surface temperatures, and pertinent surface information.

4.3.10 Calibrate the test wheel speed to the known vehicle speed in a straight line without the test tire slipping.

4.3.11 Conduct eight to ten (8 to 10) test runs for each tire being tested at a nominal vehicle speed of 8 km/h.

4.3.11.1 Activate the automatic throttle control. The throttle control shall obtain a maximum 1780 N/s measured longitudinal force increase before the test tire spins.

4.3.11.2 Apply the vehicle brakes acting on the non-test positions as required to maintain test vehicle speed.

4.3.11.3 Record the following data channels in a time history format at a minimum frequency of 100 Hz during the test run:

- Longitudinal force
- Vertical load
- Test wheel speed
- Vehicle speed

4.3.11.4 An invalid snow traction test run occurs when a test tire digs through to either the base road material or to ice during tire acceleration or spin. Data for invalid test runs are not to be considered during the data analysis.

5 Data

5.1 Calculations.

5.1.1 Data Reduction Procedure.

5.1.1.1 Calculate spinning coefficients for each test run by dividing the average longitudinal force by the average vertical load over the data period of the test run. The data period for each test run begins when longitudinal slip velocity equals 3.2 km/h, and ends 1.5 s later with a minimum longitudinal slip velocity of 16 km/h.

$$\text{Spinning Coefficient } t = \frac{(\text{Longitudinal Force})_{\text{average}}}{(\text{Vertical Force})_{\text{average}}}$$

Where:

Spinning Coefficient = Average driving coefficient over the data period for a test run, (N/N)

Longitudinal Force = Average longitudinal force over the data period, (N)

Vertical Force = average vertical force over the data period, (N)

5.1.1.2 For each test, calculate the average and sample standard deviation of the spinning coefficients from the individual test runs.

5.1.1.3 Delete spinning coefficients for a test run if it falls outside the average ± 1.5 sample standard deviations within each test.

5.1.1.4 Re-compute the average spinning coefficient and sample standard deviation after any deletions from 5.1.1.3.

5.1.2 Calculate the driving traction ratings using the weighted control tire technique described in Appendix A, Section A3.

5.1.2.1 The control tire spinning coefficients are averaged for a sequence of tests to be analyzed as a group.

5.1.2.2 Each test tire average spinning coefficient is then adjusted by multiplying by the ratio of the overall control tire spinning coefficient (5.1.2.1), to the average spinning coefficient of the individual control tires tested before and after the test tire.

5.2 Interpretation of Results. See sourcing documents.

5.3 Test Documentation. The test results documentation should include the following:

GM Confidential

© Copyright 2013 General Motors Company All Rights Reserved

November 2013

Page 4 of 11