



SURFACE VEHICLE RECOMMENDED PRACTICE

J1379™

NOV2020

Issued 1983-08
Stabilized 2020-11

Superseding J1379 AUG1983

Rolling Resistance Measurement Procedure for Highway Truck and Bus Tires

RATIONALE

This technical report is being stabilized because the technical committee has determined that the using community is moving towards newer technology and would like to alert users that this new technology exists which may want to be considered for new design. Refer to SAE J1269 and SAE J1270 for rolling resistance measurement.

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ROLLING RESISTANCE MEASUREMENT PROCEDURE FOR HIGHWAY TRUCK AND BUS TIRES—SAE J1379 AUG83

SAE Recommended Practice

Report of the Truck and Bus Fuel Economy Committee, approved June 1982, last revised August 1983.

1. Introduction—The rolling resistance of pneumatic tires results in a significant loss of energy in the operation of motor vehicles. This recommended practice provides methods for determining rolling resistance data of highway truck and bus tires under controlled conditions. This procedure is intended to provide a way of gathering data on a uniform basis to be used in comparison with test results from road fuel economy tests.

A companion document, SAE Information Report J1380, "The Measurement of Highway Truck and Bus Tire Rolling Resistance," enlarges on this subject and gives background information. The format of both documents is the same, with corresponding topics presented under the same headings.

2. Scope—This recommended practice applies to the laboratory measurement of the rolling resistance of pneumatic tires designed primarily for use on trucks and buses in normal highway service, as defined by the Tire and Rim Association, Inc. (TRA); it does not include light truck tires (designated LT). The procedure applies only to straight, free-rolling tires under steady-state operation and includes the following three basic methods:

2.1 Force Method—Measures the reaction force at the tire spindle and converts it to rolling resistance.

2.2 Torque Method—Measures the torque input to the test machine and converts it to rolling resistance.

2.3 Energy Method—Measures the energy input to the test machine and converts it to rolling resistance.

3. Definitions—The following definitions apply wherever the terms and expressions are used in this recommended practice and in SAE Information Report, J1380.

3.1 Rolling Resistance—Rolling resistance of the free-rolling tire is the scalar sum of all contact forces tangent to the test surface and parallel to the wheel plane of the tire.

3.2 Rolling Resistance Coefficient—Rolling resistance coefficient is the ratio of the rolling resistance to the load on the tire.

3.3 Loaded Radius—Loaded radius is the perpendicular distance from the axis of rotation of the loaded tire to the surface on which it is rolling.

3.4 Maximum Load—Maximum load is a force equivalent to the maximum dual (D) tire load limit specified in the tire load tables of the current Tire and Rim Association, Inc. (TRA) Yearbook.

3.5 Rated Pressure—Rated pressure is the cold inflation pressure specified for the maximum dual (D) tire load limit (maximum load) in the tire load tables of the current Tire and Rim Association, Inc. (TRA) Yearbook.

3.6 Capped Air—The term capped air refers to the process of inflating the tire to the required pressure while it is at ambient temperature of the test area, and then sealing off the pressure in the tire with a valve, cap or some other seal. As the tire is run under load, increases in temperature will cause the capped air in the tire to increase in pressure.

3.7 Regulated Air—The term regulated air refers to the process of inflating the tire to the required pressure independent of its temperature, and maintaining this inflation pressure while the tire runs under load. This is most commonly done by using a regulated pressure source attached to the tire through a rotating union.

4. Test Equipment—The laboratory test wheel is most commonly used for this procedure because of its widespread availability.

4.1 Test Surface

4.1.1 TEST WHEEL DIAMETER—The diameter of the laboratory test wheel most commonly used is 67.23 in (1.7076 m).¹

4.1.2 WIDTH—The width of the test surface must exceed the tread width of the test tire.

4.1.3 TEXTURE—A medium coarseness, abrasive-type (80 grit) surface texture is recommended, such as Medium-grit 3M Safety-Walk.

4.2 Test Rims—Test rims should have an approved contour and width as specified by the Tire and Rim Association, Inc., for the size of the tire tested. The rim width and contour used should be reported with the test results. The radial and lateral rim runout should not exceed 0.070 in (1.8 mm).

¹ Conversions between U. S. Customary Units and metric units are made in accordance with "Rules for SAE Use of SI Metric Units (SAE J916c)." The conversion factors between units depend on the precision of the base measurement to be converted.

4.3 Alignment and Control Accuracies—All test parameters should be maintained at their specified levels. Deviation from these levels will cause variations of rolling resistance. If these levels cannot be achieved as indicated in the SAE Information Report, J1380, corrections for these effects may be attempted (particularly for alignment or temperatures). All parameters should be measured and recorded with the rolling resistance values. The three measurement methods are differently affected by variations in test parameters. Except for more stringent limits specified below for each of the three methods, the test parameters should be maintained within the following limits:

Tire load application normal to test surface: ± 0.3 deg
Wheel plane alignment normal to test surface: ± 0.3 deg
Slip angle on test surface: ± 0.1 deg
Tire load: ± 10 lbf (± 44 N)
Inflation pressure: ± 0.2 psi (± 1.4 kPa)
Speed: ± 1 mph (± 2 km/h)
Ambient temperature: $75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{C}$)

4.3.1 FORCE METHOD—Misalignment of the applied load may cause a significant spindle force component to appear in the direction of the rolling resistance. Therefore, the following more stringent limit is recommended for this method:

Tire load application normal to test surface: ± 0.05 deg

4.3.2 TORQUE METHOD—Slip angle misalignment can cause a significant input torque that will be read as rolling resistance. Therefore, the following more stringent limit is recommended for this method:

Slip angle on test surface: ± 0.05 deg

4.3.3 ENERGY METHOD—Slip angle misalignment can cause a significant electrical power input that will be read as rolling resistance. Also, the rolling resistance calculation requires a constant value of speed during the measurement interval because variations in surface speed can cause significant errors. Therefore, the following more stringent limits are recommended for this method:

Slip angle on test surface: ± 0.05 deg
Speed: ± 0.5 mph (± 0.8 km/h)

4.4 Instrumentation Accuracy—The instrumentation used for read-out and recording of test data must be sufficiently accurate and precise to provide repeatable measurements of rolling resistance data. The absolute error limits specified below should produce a composite error of less than ± 0.5 lbf (± 2.2 N) and $\pm 1\%$ of the maximum rolling resistance measurement data. Refer to SAE Information Report, J1380, for the assumptions leading to the accuracy level and for appropriate changes in accuracies for specific applications. Measurements common to all three methods of rolling resistance determination should be maintained within the following accuracy limits:

Tire load: ± 6 lbf (± 26 N)
Inflation pressure: ± 0.2 psi (± 1.4 kPa)
Average temperature: $\pm 0.5^\circ\text{F}$ ($\pm 0.2^\circ\text{C}$)
Speed: ± 0.5 mph (± 0.8 km/h)

4.4.1 FORCE METHOD—In addition to the common accuracies specified above, the use of this method requires the following recommended accuracies:

Spindle force: ± 0.20 lbf (± 0.8 N)
Loaded radius: ± 0.1 in (± 2.5 mm)

4.4.2 TORQUE METHOD—In addition to the common accuracies specified above, the use of this method requires the following recommended accuracy:

Torque input: ± 6 lbf-in (± 0.7 Nm)

4.4.3 ENERGY METHOD—In addition to the common accuracies specified above, the use of this method requires the following recommended accuracies:

Electrical power: ± 20 W
Surface speed: ± 0.2 mph (± 0.3 km/h)

