



SURFACE VEHICLE RECOMMENDED PRACTICE

J2263™

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(R) Road Load Measurement Using Onboard Anemometry and Coastdown Techniques

RATIONALE

This document has been updated to align it with SAE J2264 and Environmental Protection Agency guidance CD-15-04, issued February 23, 2015. The document has also been edited for clarity.

1. SCOPE

This SAE Recommended Practice establishes a procedure for determination of vehicle road load force for speeds between 115 km/h and 15 km/h (or between 70 mph and 10 mph). It employs the coastdown method and applies to vehicles designed for on-road operation. The final result is a model of road load force (as a function of speed) during operation on a dry, level road under reference conditions of 20 °C (68 °F), 98.21 kPa (29.00 in-Hg), no wind, no precipitation, and the transmission in neutral.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1263 Road Load Measurement and Dynamometer Simulation Using Coastdown Techniques

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

Andrews, R. and Pruess, D., "Determination of Coastdown Mechanical Loss Ambient Correction Factors for use with J2263 Road Tests," SAE Technical Paper 970269, 1997, <https://doi.org/10.4271/970269>.

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SAE WEB ADDRESS:

Full document details: SAE J2263_202005

For more information on this standard, visit
https://www.sae.org/standards/content/J2263_202005

Documents



Standard Sharing Hub

Buckley, F., "ABCD - An Improved Coast Down Test and Analysis Method," SAE Technical Paper 950626, 1995, <https://doi.org/10.4271/950626>.

Buckley, F., Marks, C., and Walston, W., "Analysis of Coast-Down Data to Assess Aerodynamic Drag Reduction on Full-Scale Tractor-Trailer Trucks in Windy Environments," SAE Technical Paper 760850, 1976, <https://doi.org/10.4271/760850>.

Dayman, B., "Realistic Effects of Winds on the Aerodynamic Resistance of Automobiles," SAE Technical Paper 780337, 1978, <https://doi.org/10.4271/780337>.

Dayman, B., "Tire Rolling Resistance Measurements From Coast-Down Tests," SAE Technical Paper 760153, 1976, <https://doi.org/10.4271/760153>.

Passmore, M. and Le Good, G., "A Detailed Drag Study Using the Coastdown Method," SAE Technical Paper 940420, 1994, <https://doi.org/10.4271/940420>.

Smith, J., Tracy, J., and Potter, D., "Tire Rolling Resistance - A Speed Dependent Contribution," SAE Technical Paper 780255, 1978, <https://doi.org/10.4271/780255>.

Thompson, G., "Prediction of Dynamometer Power Absorption to Simulate Light Duty Truck Road Load," SAE Technical Paper 770844, 1977, <https://doi.org/10.4271/770844>.

Walston, W., Buckley, F., and Marks, C., "Test Procedures for the Evaluation of Aerodynamic Drag on Full-Scale Vehicles in Windy Environments," SAE Technical Paper 760106, 1976, <https://doi.org/10.4271/760106>.

White, R. and Korst, H., "The Determination of Vehicle Drag Contributions from Coast-Down Tests," SAE Technical Paper 720099, 1972, <https://doi.org/10.4271/720099>.

Yasin, T., "The Analytical Basis of Automobile Coastdown Testing," SAE Technical Paper 780334, 1978, <https://doi.org/10.4271/780334>.

2.2.2 ISO Publications

Copies of these documents are available online at <http://webstore.ansi.org/>.

ISO/DIS 10521:1991-07-31 Motor Vehicle Road Load - Determination Under Reference Atmospheric Conditions and Reproduction on Chassis Dynamometer

2.2.3 Sample Program

A working sample program is furnished as a proposed method of following this document. The full executable program, sample data, instructions, and the underlying visual basic code can be obtained at:

https://drive.google.com/open?id=1f9E-Fncm3b_U2MYSap1y619VlenlhRNP

3. DEFINITIONS

3.1 AMBIENT TEMPERATURE

The true air temperature shielded from the sun and track.

3.2 CONSTRAINED ANALYSIS

An analysis option in which the coefficients used to describe the road load force are determined using values for vehicle frontal area and coefficient of aerodynamic drag that were determined independently.

3.3 DRIVELINE

The rotating components of a vehicle mechanically connected to the driving wheels when the transmission is in neutral gear or mode. This includes the brake disks/drums, drive shafts, differential, propeller shaft, transmission output shaft, and some components within the transmission.

3.4 EFFECTIVE TEST TRACK MASS (M_{TE})

The effective mass of an individual test vehicle, including the vehicle's mass (as determined by weighing) plus the equivalent mass of rotating components:

$$M_{TE} = M_{VEH} + M_R \quad (\text{Eq. 1})$$

Using 3.5 to estimate the equivalent mass of rotating components, M_{TE} can be calculated as follows:

$$M_{TE} = 1.03 \cdot M_{VEH} \quad (\text{Eq. 2})$$

3.5 EQUIVALENT MASS OF ROTATING COMPONENTS (M_R)

This is the contribution of rotational inertia to the resistance of the vehicle to longitudinal motion. For light-duty vehicles, the rotational inertia is typically estimated to be equal to 3% of the vehicle's mass:

$$M_R = 0.03 \cdot M_{VEH} \quad (\text{Eq. 3})$$

This estimate is not applicable for vehicles with other than single, normal-sized wheels, such as dual-wheel trucks, or other driveline components, which are likely to result in an equivalent mass greater than 3% of the vehicle's mass. These vehicles require a more appropriate estimation or determination of the actual effective mass of the rotating drive components.

3.6 EQUIVALENT TEST WEIGHT

Test weight as dictated by U.S. Code of Federal Regulations (40 CFR §86) that is assigned to represent a class of test vehicles.

3.7 MECHANICAL DRAG (D_{mech})

The force opposing vehicle movement due to tire rolling resistance and friction in the driveline and non-drive axle components.

3.8 RELATIVE WIND SPEED (V_r)

Apparent wind speed relative to the vehicle. This is the magnitude of the relative wind vector, which is the ambient wind velocity relative to vehicle velocity. Wind velocity is assumed to lie in the horizontal plane.

3.9 ROAD LOAD FORCE

The total force encountered by a vehicle by reason of motion on a level, smooth surface; it includes aerodynamic and mechanical drag components and is expressed as a function of vehicle speed.

3.10 TEST VEHICLE MASS (M_{VEH})

The mass of the vehicle at the conclusion of the test; including driver, instrument operator (if any), and all instrumentation.

3.11 YAW ANGLE (Y)

Wind direction relative to the direction of vehicle travel. This is the angle between the vehicle body longitudinal axis and the relative wind vector. Yaw angle has a value of zero when the wind vector and vehicle velocity vector are in opposite directions, and is positive when the wind approaches the vehicle from the left.

4. SYMBOLS

See Table 1.

Table 1 - Symbols

Symbol	Units	Description
A	m ²	frontal area
a ₀ .. a _n	deg ⁻ⁿ	coefficients for aerodynamic drag, as a function of yaw angle
A _m	N	coefficient of mechanical drag
B _m	N/(km/h)	coefficient of mechanical drag
C _m	N/(km/h) ²	coefficient of mechanical drag
Baro	kPa	barometric pressure
C _d (Y)		coefficient of aerodynamic drag at yaw angle Y
D	N	magnitude of generic drag force acting opposite of the direction of motion
D _{aero}	N	aerodynamic drag
D _{grav}	N	gravitational drag
D _{mech}	N	mechanical drag
(dV/dt)	ms ⁻²	acceleration
F ₀	N	coefficient of road load force
F ₁	N/(km/h)	coefficient of road load force
F ₂	N/(km/h) ²	coefficient of road load force
g	ms ⁻²	gravitational constant 9.80665
(dh/ds)		grade
M _{VEH}	kg	test vehicle mass
M _{TE}	kg	effective test track mass
M _R	kg	equivalent mass of rotating components
ρ	kg/m ³	air density
t	seconds	time
T	°C	average ambient temperature
V	km/h	vehicle speed
V _r	km/h	relative wind speed
Y	degrees	yaw angle

5. INSTRUMENTATION

5.1 Calibration

All instrumentation shall be calibrated. Calibration intervals should be according to good engineering judgment and in accordance with the equipment manufacturer's specifications.

5.2 Time

(Elapsed) time shall be measured to an accuracy of ± 0.001 second and shall be recorded to a resolution of 0.01 second.

5.3 Vehicle Speed

Vehicle speed shall be measured to an accuracy of 0.2 km/h (0.1 mph) and shall be recorded to a resolution of 0.2 km/h (0.1 mph).

5.4 Relative Wind Speed

Relative wind speed should be measured at the approximate mid-point of the vehicle's frontal cross section and approximately 2 m (6.6 feet) in front of it. Relative wind speed shall be measured to an accuracy of 1 km/h (0.6 mph) and shall be recorded to a resolution of 1 km/h (0.6 mph). Calibration of the anemometer shall include corrections for vehicle "blockage." (This is not the only possible measurement location. Caution must be used to determine the wind velocity correction factor at the exact measurement location.)

5.5 Yaw Angle

Yaw angle should be measured at the approximate mid-point of the vehicle's cross section and approximately 2 m (6.6 feet) in front of it. Yaw angle shall be measured to an accuracy of 3 degrees and shall be recorded to a resolution of 1 degree. The "dead band" of the instrument shall not exceed 10 degrees and shall be directed toward the rear of the vehicle. Calibration of the instrument shall include corrections for vehicle "blockage." (This is not the only position that can be used. Caution must be used to determine the measured versus actual yaw angle transfer function for the exact measurement location.)

5.5.1 Exception

When the relative wind direction instrument is calibrated by means of operation on the vehicle undergoing the road load determination, and where such calibration occurs as part of the test sequence (including pre- and post-test operation) and without removing or installing the instrument, the accuracy requirements set forth do not apply. (Under these limitations, the calibration of the instrument to account for vehicle blockage makes an "accuracy" specification unnecessary; as long as the instrument responds the same way during calibration and testing, the needs of the procedure are satisfied.)

5.6 Ambient Temperature

Ambient temperature shall be measured to a resolution and accuracy of 1 °C (1.8 °F) in a location that is not influenced by the vehicle. Check for temperature measurement duration/average.

5.7 Barometric Pressure

Barometric pressure shall be measured to a resolution and accuracy of 0.3 kPa (0.1 in-Hg). Data from a central facility weather station is acceptable. Track-side pressure readings are preferred.

5.8 Vehicle Mass

Test vehicle mass shall be measured to an accuracy of ± 10 kg (22 pounds). For vehicles with a test mass over 4000 kg (8818 pounds), the accuracy requirement is ± 20 kg (44 pounds).

6. VEHICLE PREPARATION

6.1 Break-In

The test vehicle should be in the condition and adjustment recommended by the manufacturer for normal operation. For regulatory testing, the test vehicle and tires should be aged with sufficient mileage to represent the road load force at the 4000-mile (6440-km) test point. Mileage accumulation should be conducted at speeds and loads that are representative of both subsequent coastdown and dynamometer testing.

NOTE: For example, heavy-duty vehicles may be ballasted to the adjusted loaded vehicle weight, as specified in 40 CFR §86.1803-01, 40 CFR §1066.805.

Tires may be broken in separately from the test vehicle, either using a different vehicle or test method, provided that they are broken in to an equivalent mileage as the test vehicle and similar load conditions. Mileage accumulation for vehicles with multiple driveline modes should be conducted using the same mode that will be used for road load determination.

6.2 Vehicle Check-In

The test vehicle shall be identified. The test vehicle should be in the condition and adjustment recommended by the manufacturer for normal operation. Any differences from the normal configuration or any mechanical malfunctions shall be described. The following information shall be recorded prior to the test:

- a. Vehicle description including make, model, model year, body style, vehicle identification number (VIN), engine, and transmission type.
- b. Tire size, manufacturer, Tire Identification Number (TIN) for each tire (if available), Tire Performance Criteria (TPC) or equivalent (if available), and the depth of tread on each tire.
- c. Aerodynamic drag coefficient only if “constrained analysis” is to be used.
- d. Frontal area.
- e. Vehicle ride heights measured using the procedure specified by the manufacturer. Or, if no such procedure is specified, to top of the wheel well, or equivalent, for each wheel at test conditions.
- f. Manufacturer’s minimum recommended tire inflation pressure.
- g. Abnormal wheel bearing and brake drag (if present).
- h. Wheel alignment parameters (should be representative of manufacturer’s mean specification).

NOTE: For regulatory testing purposes, the test vehicle should be representative of the sub-configuration for which the road loads are being determined.

6.3 Vehicle Maintenance

If necessary, fluid levels shall be corrected to manufacturer’s specifications.

6.4 Instrumentation

Any instrumentation shall be installed on the vehicle in such a manner as to minimize effects on the operating characteristics of the vehicle.

6.5 Fuel

The vehicle should have sufficient fuel to complete the testing. However, the fuel volume may be adjusted if necessary to meet any ballasting and attitude requirements.