SURFACE VEHICLE RECOMMENDED PRACTICE

J2177™ MAR2026

Issued 1992-04
Revised 2026-03

Superseding J2177 APR1992

Chassis Dynamometer Test Procedure - Heavy-Duty Road Vehicles

RATIONALE

This procedure has been updated for formatting issues related to the calculation of the air correction factor.

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1. SCOPE

This SAE Recommended Practice has been adopted by SAE to specify:

a. A standard procedure for chassis dynamometer testing of heavy-duty road vehicles for the purpose of determining power delivered through the drive tires.

b. A method of correcting observed power to reference test conditions.

c. A method of analyzing the test data to determine if the test results are within expected power ranges.

1.1 Field of Application

This document is applicable to DOT Class 6, 7, and 8 on- and off-highway heavy-duty road vehicles equipped with compression ignition engines, manual or automatic transmissions, and single or tandem rear drive axles.

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: 1-877-606-7323 (U.S. and Canada only) or 1-724-776-4970 (outside U.S. and Canada), www.sae.org.

SAE J1587 Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Applications

SAE J1708 Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications

SAE J1995 Engine Power Test Code - Spark Ignition and Compression Ignition - Gross Power and Torque Rating

3. DEFINITIONS

3.1 GROSS BRAKE POWER

The power of an engine when configured with only the built-in equipment required for self-sustained operation in accordance with SAE J1995. This does not include accessory power as defined in 3.2.

3.2 ACCESSORY POWER

Power required to drive engine or chassis components that are necessary to perform the intended service or that power auxiliary systems. These components normally include the chassis inlet and exhaust systems, cooling fan, alternators/generators, vacuum pumps, power steering pumps, and air and freon compressors, operating as described in Sections 4 and 5. All engine or chassis parasitic power losses incurred during the chassis dynamometer test that are not included in the gross brake power shall, for the purpose of this procedure, be considered accessory power.

3.3 FLYWHEEL POWER

The power of an engine as installed in the chassis and measured at the flywheel. Flywheel power is the net difference between gross brake power and accessory power.

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3.4 DRIVETRAIN EFFICIENCY

The ratio of the sum total of the power delivered to all drive wheels to the flywheel power. This includes power losses generated by the transmission, driveshaft, carriers, and axles. It does not include tire rolling resistance losses. Drivetrain efficiency may vary with the speed of the vehicle as well as the amount of torque transmitted. It is normally supplied by the vehicle component manufacturer.

3.5 ROLLING RESISTANCE POWER

The power required to overcome the rolling resistance of all drive tires. This power normally varies with the type of tires, tread pattern, inflation pressure, vehicle weight on the drive tires, vehicle speed, and/or dynamometer roller surface.

3.6 TIRE-ROLLER SLIP POWER

The net difference between the power delivered through the drive tires and that transmitted to the dynamometer rollers. This power loss is due to tire to roller relative slip and is normally dissipated as heat. Tire-roller slip power can be significant and may vary with the type of tire, tread pattern, inflation pressure, roller surface, roller diameter, as well as the test speed and torque application.

3.7 OBSERVED DYNAMOMETER POWER

The observed vehicle power with no corrections made as measured by the chassis dynamometer using the equipment and procedures defined in Sections 4 and 5.

3.8 DYNAMOMETER MACHINE LOSSES

The net difference between the power delivered to the dynamometer rollers and that measured by the dynamometer load cell. These include windage or bearing power losses as well as any unaccounted for load cell calibration error.

3.9 OBSERVED WHEEL POWER

The observed dynamometer power adjusted only for dynamometer machine losses, if any. If these losses are not known and cannot be accounted for, then observed wheel power is assumed equivalent to observed dynamometer power.

3.10 CORRECTED WHEEL POWER

The observed wheel power corrected to reference test conditions.

3.11 EXPECTED WHEEL POWER

The vehicle power that would normally be expected to be transmitted to the dynamometer if the test were run at reference test conditions. This is calculated by subtracting estimated accessory, drivetrain, and rolling resistance power losses from the engine gross brake power.

3.12 REFERENCE TEST CONDITIONS

The standard or reference test conditions to which all power corrections are made per 6.1. These corrections are made to reference engine inlet air and fuel conditions as well as to account for tire-roller slip.

3.13 REFERENCE TEST SPEED

The highest engine speed that can be attained in direct drive gear with the throttle fully depressed and the dynamometer rollers turning but fully unloaded. At the reference test speed, the observed dynamometer power should be at or near zero and tire-roller slip power is assumed to be negligible since there is little or no torque transmitted to the dynamometer.

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3.14 SET POINT SPEED

This is also sometimes referred to as the governor cut-in speed. It is the speed above which the engine governor begins to significantly reduce engine power. The set point speed is normally specified to preclude governor interference with engine power at nominal rated speed and is therefore normally set at slightly above rated speed.

3.15 LOW AND HIGH IDLE SPEEDS

The lowest and highest test engine speeds, respectively, that can be attained with the clutch fully disengaged (pedal depressed). At all idle speeds, flywheel power is limited to zero. The throttle pedal is not depressed at low idle and is fully depressed at high idle. Low and high idle speeds are measured with all engine accessories driven at minimum output levels.

4. TEST EQUIPMENT

This section describes the recommended test equipment necessary to perform the chassis dynamometer test.

4.1 Test Facility

4.1.1 The use of an indoor facility is recommended in order to effectively control ambient test air and fuel temperatures, which can significantly affect vehicle power. The test facility should be able to control ambient air temperature to within 25 °C ± 15 °C.

4.1.2 The test facility should be equipped with a fresh air ventilation system of sufficient capacity to maintain an adequate air supply to the test vehicle. Ambient air pressure must be maintained at a constant level in the test facility throughout the chassis dynamometer test.

4.1.3 The facility should be equipped with an exhaust ventilator system that permits engine exhaust gas to be removed directly from the test room. This ventilator tube is normally vented to atmosphere or to separate reservoir, either of which must have a total pressure of within 0.75 kPa of the ambient air pressure in the test facility.

4.1.4 The test facility should be equipped with safety chains and mounts for the test vehicle rear axle as well as tie-down straps for the front wheels. Chocks are acceptable for the front wheels only if the drive tires cradle or are cradled by the dynamometer rollers. The safety chain mounts should be positioned so as to minimize the downward force on the test vehicle when the chains are installed, resulting in an undesirable increase in rolling resistance. Ideally, the safety chain mounts should allow the chains to be positioned as close to horizontal as possible, provided they prevent lateral movement of the test vehicle during operation.

4.1.5 For vehicles having engines equipped with chassis-mounted air-to-air charge air cooling systems, it is recommended that a portable auxiliary cooling fan be available. This cooling fan should be placed directly in front of the radiator on any chassis dynamometer tests where the inlet manifold air temperature exceeds the recommended test limits as described in 5.2.6.

4.1.6 The test facility must also be equipped with other safety equipment as required by the dynamometer manufacturer, facility owner, or appropriate federal, state, and local codes. This would normally include, but not be limited to, a fire extinguisher, safety glasses, ear protection, etc.

4.2 Chassis Dynamometer

4.2.1 A computer-based dynamometer automatic control and data acquisition system is recommended but not required. This type of dynamometer can be used to automatically control test cycles and acquire, analyze, plot, and report data. Such dynamometer control systems can generally improve test uniformity, repeatability, and overall accuracy levels as well as reduce operator error and fatigue.

If the test dynamometer does not have the capability to analyze the test results in accordance with Sections 6 and 7, it is recommended that a PC-based computer program be used to analyze the test results. Refer to the engine or vehicle manufacturer for this program. In such cases, observed test data would manually be entered into the program in order to calculate corrected and expected wheel power levels.

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4.2.2 The chassis dynamometer should be designated by the manufacturer for use in this type of testing. The dynamometer must be of the non-portable variety designed to measure whole vehicle horsepower at the drive tires on single and tandem axle heavy-duty road vehicles. The expected wheel power should not exceed the dynamometer manufacturer's stated power absorption capabilities.

4.2.3 On tandem drive axle vehicles, the chassis dynamometer must be capable of adjustment as required to maintain proper tire-roller contact on all drive tires of the test vehicle.

4.2.4 Whenever possible, large-diameter dynamometer rollers are recommended in order to increase tire-roller contact area and reduce the possibility of large tire-roller slippage power losses and tire overheating. A roller diameter of 0.9 m (36 inches) or greater is recommended, although a minimum roller size of 0.5-m (20-inch) diameter is permitted. On any test where excessive tire-roller slippage or tire overheating is apparent, as described in 5.2.8, a set of auxiliary test drive tires is also recommended.

4.2.5 The test dynamometer should be calibrated by a method approved by the manufacturer at periodic intervals. On many dynamometers, this is a dead weight load cell calibration check only. In such cases, the calibration period is not to exceed every 6 months. Prior to conducting each chassis dynamometer test, check to ensure that this calibration period has not expired.

The dynamometer calibration should also include accounting for bearing, windage, or other machine losses. On certain dynamometers, these losses can be measured and automatically included in the observed dynamometer power reading. In such cases, observed dynamometer power will be equal to observed wheel power. If these losses are not automatically included in the test dynamometer calibration, then they should be accounted for in accordance with 7.2.

4.3 Instrumentation

4.3.1 The following minimum test measurements and instrumentation accuracy are recommended for the chassis dynamometer test at each test point:

a. Engine speed: ±0.2% of measured value

b. Dynamometer speed: ±0.2% of measured value

c. Observed dynamometer power: ±1.0% of measured value

d. Fuel flow: ±1.0% of measured value

e. Inlet fuel temperature: ±2.0 °C

f. Inlet air temperature: ±2.0 °C

g. Inlet manifold air temperature: ±2.0 °C

h. Inlet fuel pressure: ±2 kPa

i. Inlet manifold pressure: ±2 kPa

4.3.2 On vehicles equipped with tandem drive axles, where each axle drives a separate set of rollers (either single or paired), dynamometer speed measurements must be obtained for both axle-roller sets. On dynamometers so equipped, observed dynamometer power should also be recorded for each set of rollers. Observed dynamometer power is then corrected individually for each drive axle in accordance with 7.3.

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