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SAE J1349 JUN85

Engine Power Test Code — Spark Ignition and Diesel

SAE Standard
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ENGINE POWER TEST CODE—SPARK IGNITION AND DIESEL—SAE J1349 JUN85

SAE Standard

Report of the Engine Committee, approved December 1980, completely revised June 1985.

Contents

1. Scope—This standard has been adopted by SAE to specify:

1.1 A basis for engine power rating.

1.2 Standard inlet air conditions.

1.3 A method for correcting observed power at full load.

1.4 A basis for determining full load engine power with a dynamometer.

2. Field of Application—This standard test code is applicable to four-stroke and two-stroke cycle spark ignition and diesel engines, naturally aspirated and pressure charged, with and without charge air cooling.

3. References

3.1 This test code supersedes:

3.1.1 SAE J816b—Engine Test Code—Spark Ignition and Diesel (last issued in 1981 Handbook).

3.1.2 SAE J245—Engine Rating Code—Spark Ignition (last issued in 1981 Handbook).

3.1.3 SAE J270—Engine Rating Code—Diesel (last issued in 1981 Handbook).

3.1.4 SAE J607a—Small Spark Ignition Engine Test Code (last issued in the 1984 Handbook).

3.2 Relationship to ISO Standards 1585, 2534, and 3046:

ISO 1585 (1982)—Road Vehicles—Engine Test Code—Net Power. SAE J1349 differs from ISO 1585 in several items, among which the most important are:

This SAE Standard encompasses both gross and net power and has a wider application range.

This SAE Standard specifies fuel inlet temperature for diesel engines.

This SAE Standard provides an optional instantaneous power rating method for spark ignition engines.

This SAE Standard does not recommend conformance tolerances.

ISO 2534 (1974)—Road Vehicles—Engine Test Code—Gross Power.

ISO 3046 . . . I (1981), II (1977), III (1979), IV (1978), V (1978), VI (1982)—Reciprocating Internal Combustion Engines-Performance.

SAE J1349 is not in agreement with either ISO 3046 or ISO 2534.

ENGINE POWER RATING

4. Terminology

4.1 Net Brake Power—The measured power of a "fully equipped" engine as defined in paragraphs 4.4.2 and 11.11.

4.2 Gross Brake Power—The measured power of a "basic" engine as defined in paragraphs 4.4.1 and 11.2.

4.3 Rated Power—May be net or gross and is declared by the manufacturer at a rated engine speed.

4.4 Associated Terminology

4.4.1 A basic engine is an engine equipped only with its built-in accessories such as fuel, oil, and cooling pumps plus built-in emission control equipment.

4.4.2 A fully equipped engine is an engine equipped with accessories necessary to perform its intended service. This includes, but is not restricted to, the basic engine of paragraph 4.4.1, plus intake air system, exhaust system, cooling system, generator (alternator), starter, emissions, and noise and RFI control equipment (see paragraph 11.1).

Accessories which are not necessary for the operation of the engine, but may be engine mounted, are not considered part of a fully equipped engine. These items include, but are not restricted to, power steering pump system, vacuum pumps, and compresser systems for air conditioning, brakes, and suspensions. When these accessories are integral with the engine, the power absorbed in an unloaded condition may be determined and added to the net brake power.

4.4.3 Observed Brake Power—The power developed by an engine under the actual inlet air conditions existing during the test.

4.4.4 Corrected Brake Power—The observed power adjusted to standard inlet air conditions using the correction methods specified in Sections 7 and 8.

4.4.5 Friction Power—The power required to drive the engine alone as equipped for the power test. Friction power may be established by one of the following methods (the value is needed for power correction of spark ignition engines):

(a) Hot Motoring Friction—Record friction torque at wide open throttle at each test speed run on the power test. All readings are to be taken at the same coolant and oil temperature as observed on the power test points ±3 K.

(b) Assume 85% mechanical efficiency.

Hot motoring friction method is preferred.

4.4.6 Indicated power is the power developed in the cylinders. It is defined as the sum of the brake power and friction power for the purposes of this standard.

5. Presentation of Results—Reported corrected data must be designated as either net or gross and shall carry the notation: "Performance obtained and corrected in accordance with SAE J1349." Any deviation from this standard and its limits shall be noted. In particular, power measurements made in accordance with the optional procedure described in paragraph 15.1 must be labeled as "instantaneous."

STANDARD CONDITIONS

6. Standard Inlet Air Conditions

Inlet Air Pressure (Absolute)	100 kPa
Inlet Air Temperature	25°C
Dry Inlet Air Pressure (Absolute)	99 kPa

6.1 Useful Equivalents—See SAE J916.

CORRECTING OBSERVED POWER

7. Power Corrections—The performance of diesel and spark-ignition engines is affected by the pressure, temperature, and humidity of the inlet air. Therefore, in order to provide a common basis of comparison, it is necessary to apply a correction factor to account for the difference between standard inlet air conditions and those at which the test data were observed.

It is recommended that only test data obtained within the range of 80–110 kPa dry absolute inlet air pressure and 10–40°C inlet air temperature be used. If test data obtained outside this range are corrected, the inlet air conditions under which the test was performed shall be shown with the corrected results (see Section 5).

For aftercooled engines, if an auxiliary cooler is employed for test purposes, it should simulate the in-service air or mixture temperature in the inlet manifold, as if the inlet air temperature were 25°C. In this case, no temperature correction shall be made.

The correction formulas are not intended for altitude derating.

8. Computations

8.1 Spark Ignition Engines—Correction of brake power at wide-open throttle.

If friction power (see paragraph 4.4.5) is measured:

$$ip_o = fp_o + bp_o$$

$$ip_c = ip_o\left(\frac{99}{B_{do}}\right)\left(\frac{t+273}{298}\right)^{0.5}$$

$$bp_c = ip_c - fp_o$$

If 85% mechanical efficiency is assumed:

$$bp_c = bp_o\left[1.18\left(\frac{99}{B_{do}}\right)\left(\frac{t+273}{298}\right)^{0.5} - 0.18\right]$$

The limits for bp_c/bp_o shall be 0.93 to 1.07.

If these limits are exceeded, the corrected value obtained shall be given and the test conditions (temperature and pressure) stated in the presentation of results.

8.2 Diesel Engines—Correction of Brake Power with throttle lever in full load position:

$$bp_c = bp_o\,(fa)^{fm}$$

where:

$$fa = \left(\frac{99}{B_{do}}\right)\left(\frac{t+273}{298}\right)^{0.7}$$ for naturally aspirated and mechanically supercharged engines

or

$$fa = \left(\frac{99}{B_{do}}\right)^{0.7}\left(\frac{t+273}{298}\right)^{1.5}$$ for turbocharged and turbocharged aftercooled engines

where:

$fm = (0.036 \times q/r) - 1.14$ for values of q/r between 40 and 65

$fm = 0.3$ for values of q/r less than 40

$fm = 1.2$ for values of q/r greater than 65

where:

$q = 120\,000\ F/DN$ for four-stroke cycle engines

and

$q = 60\,000\ F/DN$ for two-stroke cycle engines

where the pressure ratio is:

$r = P_o/B_o$ ($r = 1$ for naturally aspirated engines)

The limits for bp_c/bp_o shall be 0.90 to 1.10.

If these limits are exceeded, the corrected value obtained shall be given and the test conditions (temperature and pressure) stated in the presentation of results.

8.3 Symbols and Units:

B	Inlet air pressure (absolute)	kPa
D	Engine displacement	L (dm^3)
F	Fuel flow	g/s
N	Engine Speed	r/min
P	Inlet manifold pressure (absolute)	kPa
t	Inlet air temperature	°C
fa	Atmospheric factor	
fm	Engine factor	
bp	Brake power	kW
fp	Friction power	kW
ip	Indicated power	kW
q	Fuel delivery	mg/L cycle
r	Pressure ratio (P_o/B_o)	

Subscripts:

c	Refers to data corrected to standard inlet air conditions
d	Refers to the dry air portion of the total pressure
o	Refers to data observed at the actual test conditions

TEST PROCEDURES

This section contains the required test procedures for determining engine power.

9. Data

9.1 Gross and Net Brake Power—Record data for at least five approximately evenly spaced operating speeds to define the power curve between 600 r/min (or the lowest stable speed) and the maximum engine speed recommended by the manufacturer. One of the operating speeds must be the rated speed.

9.2 Data to be Recorded for Test Documentation (for accuracies see Section 10).

1) Brake torque (labeled "instantaneous," if applicable) (see paragraph 15.1).
2) Speed (see paragraph 15.1).
3) Friction torque (if measured) (see paragraph 4.4.5).
4) Ambient air pressure (see paragraph 15.4).
5) Inlet air water vapor pressure.
6) Inlet air pressure and temperature (see paragraphs 14.1 and 15.4).
7) Pressure drop across engine inlet air system.
8) Inlet-manifold air pressure and temperature (for pressure charged engines (see paragraph 14.2).
9) Fuel supply pressure.
10) Fuel flow and temperature (see paragraph 14.5).
11) Ignition and/or injection timing.
12) Oil pressure and temperature (see paragraph 14.4).
13) Coolant temperature (see paragraph 14.3).
14) Exhaust pressure (see paragraphs 14.6 and 15.4).
15) Pressure drop across engine exhaust system (net test only).
16) Exhaust smoke (for diesel engines).
17) Engine equipment (see Section 11).

10. Instrumentation Accuracy

10.1 Torque—±0.5% of measured value.
10.2 Speed—±0.2% of rated speed.
10.3 Temperatures—±2 K.
10.4 Inlet Air Pressures—±0.1 kPa.
10.5 Other Gas Pressures—±0.5 kPa.
10.6 Fuel Flow—±1% of measured value.

11. Engine Equipment

11.1 Net Brake Power—A fully equipped engine is used for this test (see paragraph 4.4.2).

1) Air preheat (if applicable)—on.
2) Inlet system—on, or a system providing equivalent restriction at all speeds and loads.
3) Air cleaner—on.
4) Radiator—not used.[1]
5) Fan—not used, but losses accounted for[2] —liquid cooled.
6) Fan or blower—on, air control mechanism operating normally—air-cooled.
7) Exhaust system—on, or system providing equivalent restriction at all speeds and loads.
8) Heat valve—open.
9) Timing—manufacturer's specification.
10) Spark advance—manufacturer's specification—for engines equipped with knock sensors and/or electronic controls, the spark advance must be representative of in-vehicle conditions established with the minimum octane fuel recommended by the manufacturer.
11) Fuel pump setting—manufacturer's specification.
12) Carburetor or fuel metering control setting—manufacturer's specification.
13) Boost pressure control setting—manufacturer's specification—for spark ignition engines equipped with variable boost as a function of charge (or inlet) air temperature and/or engine speed, the boost pressure must be representative of in-vehicle conditions established with the minimum octane fuel as recommended by the manufacturer.
14) Emission, noise, and RFI control equipment—manufacturer's specification.
15) Governor—on, if integral part of engine.
16) Generator (alternator)—on, but not charging (see exceptions paragraph 15.5).
17) Spark plugs—manufacturer's specification or colder.

11.2 Gross Brake Power—A basic engine is used for this test (see paragraph 4.4.1) using the same equipment and settings as for Net Brake Power, with the following exceptions:

1) Air preheat—not used.
2) Inlet system—laboratory system which provides ambient air to the inlet of the engine.
3) Radiator—not used—liquid-cooled engine only.
4) Fan—not used—liquid-cooled engine only.
5) Exhaust system—a laboratory system which removes exhaust gas from the outlet of the engine.
6) Emission, noise, and RFI controls integral with engine—manufacturer's specification.
7) Generator (alternator)—not used unless required to drive built-in equipment. If used, the power absorbed by the unloaded generator may be added to the corrected power.

12. Fuels and Lubricants

12.1 Fuel used shall conform to the manufacturer's recommendation.

12.1.1 Spark Ignition Engines

[1] In certain special cases such as generator sets, the radiator may be installed. In these cases, the fan is also required.

[2] Fan power should be determined by a separate test. When a viscous coupling is used, the coupling should operate at maximum slip. To avoid the need for fan power corrections, fan power test shall be run at conditions of ±5% of SAE reference atmosphere density. In the case of an electrically driven fan or a fan equipped with electromagnetic clutch which can be fully disengaged, the fan power shall be neglected.