



**DIESEL ENGINE EMISSION MEASUREMENT
PROCEDURE—SAE J1003**

SAE Recommended Practice

Report of Automotive Emissions Committee approved March 1973.

1. Introduction—This SAE Recommended Practice is intended for use as a test procedure to determine the gaseous emission levels of diesel engines.

The emission results for hydrocarbons, nitrogen oxides, and carbon monoxide are expressed in mass units of grams per brake horsepower-hour and represent the mass rate of emissions per unit of work accomplished.

The emissions are measured during an engine dynamometer test on a 3-speed, 13-mode, steady-state cycle.

The emissions are measured in accordance with SAE Recommended Practices using nondispersive infrared equipment for CO and NO and a heated flame ionization analyzer for HC and are measured during steady-state engine operation primarily to allow the hydrocarbon emissions to stabilize. The mass rate of emissions is calculated from the concentration in the exhaust gas and the exhaust flow for each mode. The final emissions are calculated by either dividing the emission mass rate by the brake horsepower in each mode, or by dividing the summation of the weighted emission mass rate by the summation of the weighted brake horsepower values for a cycle.

2. General Provisions

2.1 Definitions

2.1.1 DIESEL ENGINE—A compression ignition engine.

2.1.2 EXHAUST EMISSION—Substances emitted to the atmosphere from any opening downstream from the exhaust port of an engine.

2.1.3 RATED BRAKE HORSEPOWER—The maximum brake horsepower output of an engine as stated by the manufacturer (in accordance with SAE J816).

2.1.4 RATED SPEED—The speed at which the manufacturer specifies the rated brake horsepower of an engine.

2.1.5 RATED TORQUE—The maximum torque produced by an engine, as stated by the manufacturer.

2.1.6 PEAK TORQUE SPEED—The speed at which the engine develops maximum torque, as stated by the manufacturer.

2.1.7 PERCENT LOAD—The fraction of the maximum available torque at that engine speed.

2.1.8 INTERMEDIATE SPEED—The peak torque speed or 60% of rated speed, whichever is higher.

2.1.9 IDLE SPEED—The manufacturer's low idle speed.

2.2 Abbreviations—The abbreviations used in this recommended practice have the following meanings in both capital and lower case:

- API — American Petroleum Institute
- ASTM — American Society for Testing and Materials
- bhp (W) — Brake horsepower (watts)
- BSHC — Brake specific hydrocarbons
- BSNO_x — Brake specific nitrogen oxides
- BSCO — Brake specific carbon monoxide
- CO — Carbon monoxide
- Conc — Concentration
- EP — End Point
- exh — Exhaust
- °F (K) — Fahrenheit (Kelvin)
- ft (m) — Feet (metre)
- g — Gram(s)
- HC — Hydrocarbon(s)
- Hg — Mercury
- hp (W) — Horsepower (watts)
- h — hour
- IBP — Initial boiling point
- in (m) — Inch(es) (metre)
- lb (N) — Pound(s) (newton)
- min — Minimum — minute
- NO_x — Nitrogen oxides
- obs — Observed
- ppm — Parts per million by volume

- rpm — Revolutions per minute
- WF — Weighting factor
- ∑ — Summation

3. Engine Dynamometer Test Procedure

3.1 Introduction—The test procedure consists of a prescribed sequence of engine operating conditions of an engine dynamometer with measurement of HC, NO, and CO during 13 steady-state modes with 5 modes at rated engine speed, 5 modes at an intermediate engine speed, and 3 modes at idle speed.

3.2 Fuel Specification

3.2.1 The diesel fuels employed shall be clean and bright, with pour and cloud point adequate for operability. The fuels may contain non-metallic additives as follows: cetane improver, metal deactivator, anti-oxidant, dehazer, antirust, pour depressant, dye, and dispersant.

3.2.2 Fuel meeting the following specifications shall be used in exhaust emission testing:

Item	ASTM Test No.	Range
Cetane No.	D613	42–50
Distillation range	D86	
16P, °F (K)		340–400 (444–477)
10% point, °F (K)		400–460 (477–511)
50% point, °F (K)		470–540 (516–555)
90% point, °F (K)		550–610 (561–594)
EP, °F (K)		580–660 (577–622)
Gravity, °API	D287	33–37
Total sulfur, % max	D129	0.5
Flash point, °F (K), min	D93	130 (327)
Viscosity, cSt (m ² /s)	D445	2.0–3.2 (× 10 ⁻⁶)

3.3 Instrumentation

3.3.1 Instrumentation shall be provided to measure the following engine operating data:

- (a) Engine speed: rpm
- (b) Torque: lb-ft (N·m)
- (c) Mass fuel consumption: lb/min (kg/min)
- (d) Observed barometer: in Hg (Pa)
- (e) Water vapor pressure: in Hg (Pa)
- (f) Intake air restriction: in water (Pa)
- (g) Exhaust back pressure: in Hg (Pa)
- (h) Intake air temperature: °F (K)
- (i) Fuel temperature at pump inlet: °F (K)

3.3.2 Instrumentation shall be provided to measure the engine intake airflow or exhaust flow and the concentration of CO, NO_x, and HC in the exhaust as follows:

3.3.2.1 The determination of the CO and NO concentrations shall be accomplished using sampling and analysis by nondispersive infrared methods using SAE J177.

3.3.2.2 The determination of the HC concentration shall be accomplished using sampling and analysis by a heated flame ionization detector method using SAE J215.

3.3.2.3 The determination of the intake airflow or exhaust flow shall be accomplished using SAE J244.

3.4 Test Conditions

3.4.1 The following ranges of test conditions shall be maintained during exhaust emission testing:

- 3.4.1.1 Intake Air Temperature**—85 ± 15°F (302 ± 8 K).
- 3.4.1.2 Barometric Pressure**—29.4 ± 1 in Hg (99.6 ± 3.3 kPa).
- 3.4.1.3 Fuel Temperature at Fuel Pump Inlet**—100 ± 10°F (311 ± 5 K).
- 3.4.1.4 Intake Restriction**—Midway between the manufacturer's