

§ 89.329

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(b) Perform testing at the following inlet and exhaust restriction settings.

(1) Equip the test engine with an air inlet system presenting an air inlet restriction within 5 percent of the upper limit at maximum air flow, as specified by the engine manufacturer for a clean air cleaner. A system representative of the installed engine may be used. In other cases a test shop system may be used.

(2) The exhaust backpressure must be within 5 percent of the upper limit at maximum declared power, as specified by the engine manufacturer. A system representative of the installed engine may be used. In other cases a test shop system may be used.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57013, Oct. 23, 1998]

§ 89.329 Engine cooling system.

An engine cooling system is required with sufficient capacity to maintain the engine at normal operating temperatures as prescribed by the engine manufacturer.

[59 FR 31335, June 17, 1994. Redesignated at 63 FR 56995, Oct. 23, 1998]

§ 89.330 Lubricating oil and test fuels.

(a) *Lubricating oil.* Use the engine lubricating oil for testing that meets the requirements as specified by the manufacturer for a particular engine and intended usage. Record the specifications of the lubricating oil used for the test.

(b) *Test fuels.* (1) Use diesel fuels for testing which are clean and bright, with pour and cloud points adequate for operability. The diesel fuel may contain nonmetallic additives as follows: Cetane improver, metal deactivator, antioxidant, dehazer, antirust, pour depressant, dye, dispersant, and biocide.

(2) Use petroleum fuel meeting the specifications in Table 4 in Appendix A of this subpart, or substantially equivalent specifications approved by the Administrator, for exhaust emission testing. The grade of diesel fuel used must be commercially designated as "Type 2-D" grade diesel fuel and recommended by the engine manufacturer.

(3) Testing of Tier 1 engines rated under 37 kW or Tier 2 engines rated at

or above 37 kW that is conducted by the Administrator shall be performed using test fuels that meet the specifications in Table 4 in Appendix A of this subpart and that have a sulfur content no higher than 0.20 weight percent.

(c) Other fuels may be used for testing provided they meet the following qualifications:

(1) They are commercially available;

(2) Information acceptable to the Administrator is provided to show that only the designated fuel would be used in customer service;

(3) Use of a fuel listed under paragraph (b) of this section would have a detrimental effect on emissions or durability; and

(4) Fuel specifications are approved in writing by the Administrator prior to the start of testing.

(d) Report the specification range of the fuel to be used under paragraphs (b)(2) and (c)(1) through (c)(4) of this section in the application for certification in accordance with § 89.115 (a)(8).

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57013, Oct. 23, 1998]

§ 89.331 Test conditions.

(a) *General requirements.* Calculate all volumes and volumetric flow rates at standard conditions for temperature and pressure (0 °C and 101.3 kPa), and these conditions must be used consistently throughout all calculations.

(b) *Engine test conditions.* Measure the absolute temperature (designated as *T* and expressed in Kelvin) of the engine air at the inlet to the engine, and the dry atmospheric pressure (designated as *p* and expressed in kPa), and determine the parameter *f* according to the following provisions:

(1) Naturally aspirated and mechanically supercharged engines:

$$f = \frac{99}{p_s} \times \left(\frac{T}{298} \right)^{0.7}$$

(2) Turbocharged engine with or without cooling of inlet air:

$$f = \left(\frac{99}{p_s} \right)^{0.7} \times \left(\frac{T}{298} \right)^{1.5}$$

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(c) For a test to be recognized as valid, the parameter *f* shall be between the limits as shown below:

$$0.98 < f < 1.02$$

[59 FR 31335, June 17, 1994. Redesignated at 63 FR 56995, Oct. 23, 1998]

APPENDIX A TO SUBPART D—TABLES

TABLE 1—ABBREVIATIONS USED IN SUBPART D

CLD Chemiluminescent detector.

TABLE 1—ABBREVIATIONS USED IN SUBPART D—Continued

CO	Carbon monoxide.
CO ₂	Carbon dioxide.
HC	Hydrocarbons.
HCLD	Heated chemiluminescent detector.
HFID	Heated flame ionization detector.
GC	Gas chromatograph.
NDIR	Non-dispersive infra-red analyzer.
NIST	National Institute for Standards and Testing.
NO	Nitric Oxide.
NO ₂	Nitrogen Dioxide.
NO _x	Oxides of nitrogen.
O ₂	Oxygen.

TABLE 2—SYMBOLS USED IN SUBPARTS D AND E

Symbol	Term	Unit
conc	Concentration (ppm by volume)	ppm
<i>f</i>	Engine specific parameter considering atmospheric conditions	
F _{FCB}	Fuel specific factor for the carbon balance calculation	
F _{FD}	Fuel specific factor for exhaust flow calculation on dry basis	
F _{FH}	Fuel specific factor representing the hydrogen to carbon ratio	
F _{FW}	Fuel specific factor for exhaust flow calculation on wet basis	
FR	Rate of fuel consumed	g/h
G _{AIRW}	Intake air mass flow rate on wet basis	kg/h
G _{AIRD}	Intake air mass flow rate on dry basis	kg/h
G _{EXHW}	Exhaust gas mass flow rate on wet basis	kg/h
G _{Fuel}	Fuel mass flow rate	kg/h
H	Absolute humidity (water content related to dry air)	g/kg
<i>i</i>	Subscript denoting an individual mode	
K _H	Humidity correction factor	
L	Percent torque related to maximum torque for the test mode	%
mass	Pollutant mass flow	g/h
n _{d,i}	Engine speed (average at the <i>i</i> 'th mode during the cycle)	1/min
P _d	Dry atmospheric pressure	kPa
P _a	Test ambient saturation vapor pressure at ambient temperature	kPa
P	Observed brake power output uncorrected	kW
P _{AUX}	Declared total power absorbed by auxiliaries fitted for the test	kW
P _M	Maximum power measured at the test speed under test conditions	kW
P ₁	P ₁ = P _{M,i} + P _{AUX,i}	
P _B	Total barometric pressure (average of the pre-test and post-test values)	kPa
P _v	Saturation pressure at dew point temperature	kPa
R _a	Relative humidity of the ambient air	%
S	Dynamometer setting	kW
T	Absolute temperature at air inlet	K
T _{bc}	Air temperature after the charge air cooler (if applicable) (average)	K
T _{clout}	Coolant temperature outlet (average)	K
T _{dp}	Absolute dewpoint temperature	K
T _{d,i}	Torque (average at the <i>i</i> 'th mode during the cycle)	N-m
T _{SC}	Temperature of the intercooled air	K
T _{ref}	Reference temperature	K
V _{EXHD}	Exhaust gas volume flow rate on dry basis	m ³ /h
V _{AIRW}	Intake air volume flow rate on wet basis	m ³ /h
P _B	Total barometric pressure	kPa
V _{EXHW}	Exhaust gas volume flow rate on wet basis	m ³ /h
WF	Weighing factor	
WF _E	Effective weighing factor	

TABLE 3—MEASUREMENT ACCURACY AND CALIBRATION FREQUENCY

No.	Item	Calibration accuracy ¹	Calibration frequency
1	Engine speed	± 2%	30 days.
2	Torque	Larger of ± 2% of point or ± 1% of engine maximum.	30 days.
3	Fuel consumption (raw measurement)	± 2% of engine maximum	30 days.
4	Air consumption (raw measurement)	± 2% of engine maximum	As required.
5	Coolant temperature	±2°K	As required.
6	Lubricant temperature	±2°K	As required.
7	Exhaust backpressure	± 1.0% of engine maximum ..	As required.
8	Inlet depression	1.0% of engine maximum	As required.

TABLE 3—MEASUREMENT ACCURACY AND CALIBRATION FREQUENCY—Continued

No.	Item	Calibration accuracy ¹	Calibration frequency
9	Exhaust gas temperature	±15°K	As required.
10	Air inlet temperature (combustion air)	±2°K	As required.
11	Atmospheric pressure	± 0.5%	As required.
12	Humidity (combustion air) (g of H ₂ O/Kg of dry air)	± 0.5	As required.
13	Fuel temperature	±2°K	As required.
14	Temperature with regard to dilution tunnel	±2°K	As required.
15	Dilution air humidity (g of H ₂ O/Kg of dry air)	± 0.5	As required.
16	HC analyzer	± 2%	Monthly or as required.
17	CO analyzer	± 2%	Once per 60 days or as required.
18	NO _x analyzer	± 2%	Monthly or as required.
19	Methane analyzer	± 2%	Monthly or as required.
20	NO _x converter efficiency check	90%	Monthly.
21	CO ₂ analyzer	± 2%	Once per 60 days or as required.

¹ All accuracy requirements pertain to the final recorded value which is inclusive of the data acquisition system.

TABLE 4—FEDERAL TEST FUEL SPECIFICATIONS

Item	Procedure (ASTM) ¹	Value (type 2-D)
Cetane	D613-95	40-48
Distillation Range:		
IBP, °C	D86-97	171-204
10% point, °C	86-97	204-238
50% point, °C	86-97	243-282
90% point, °C	86-97	293-332
EP, °C	86-97	321-366
Gravity, API	D287-92	32-37
Total Sulfur, %mass	D129-95 or D2622-98	0.03-0.40
Hydrocarbon composition:		
Aromatics, %vol	D1319-98 or D5186-96	≥ 10
Paraffins, Naphthenes, Olefins	D1319-98	(³)
Flashpoint, °C (minimum)	D93-97	54
Viscosity @ 38°C, Centistokes	D445-97	2.0-3.2

¹ All ASTM procedures in this table have been incorporated by reference. See § 89.6.

² Minimum.

³ Remainder.

[63 FR 57013, Oct. 23, 1998]

APPENDIX B TO SUBPART D—FIGURES

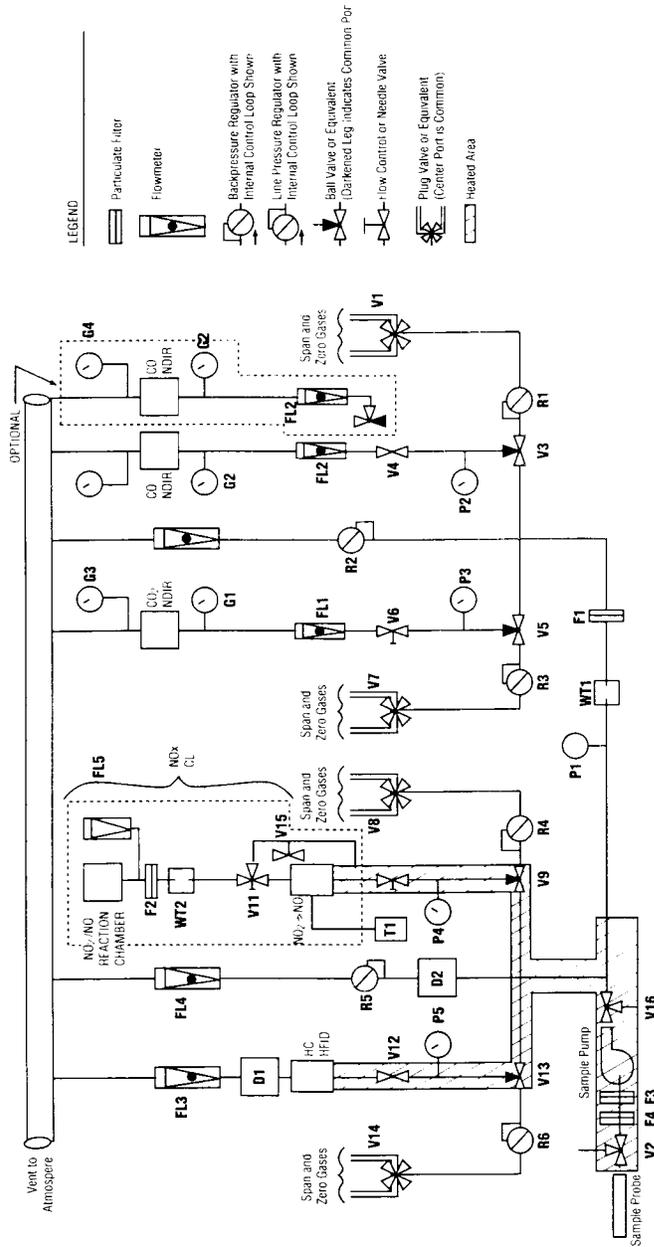


Figure 1. — Exhaust Gas Sampling and Analytical Train

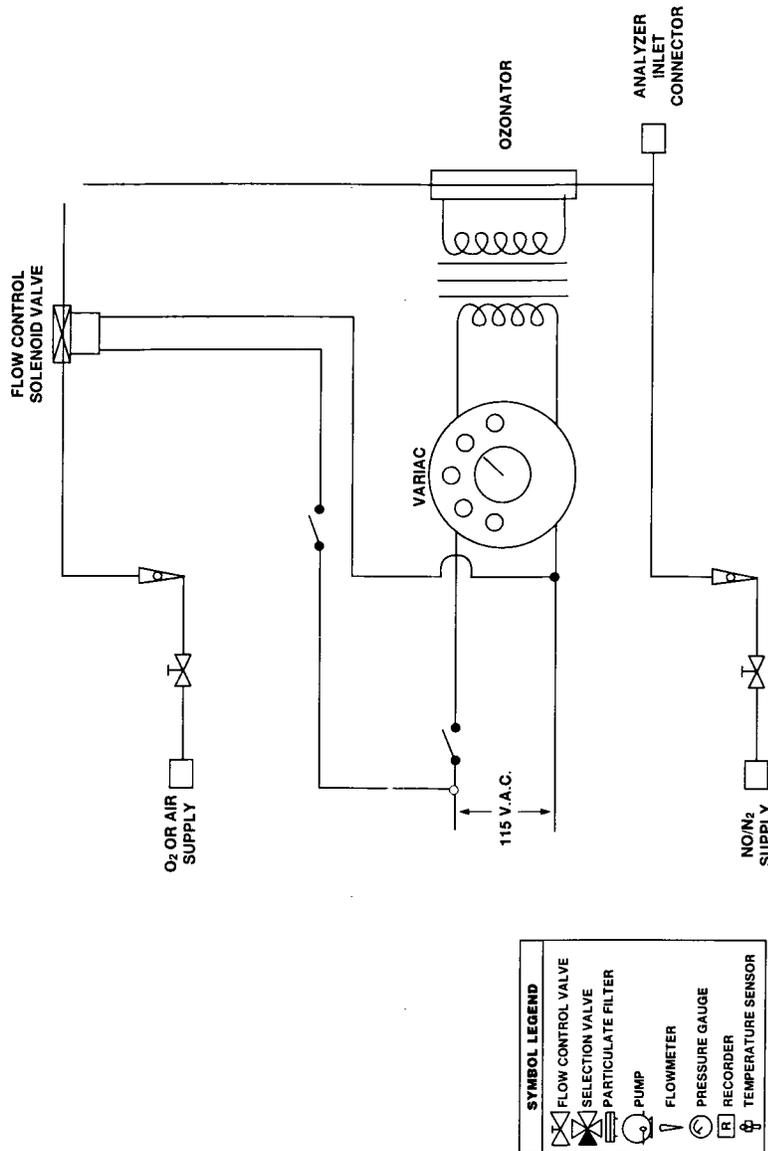


Figure 2. — NOx Converter Efficiency Detector

Subpart E—Exhaust Emission Test Procedures

§ 89.401 Scope; applicability.

(a) This subpart describes the procedures to follow in order to perform exhaust emission tests on new nonroad

compression-ignition engines subject to the provisions of subpart B of this part.

(b) Exhaust gases, either raw or dilute, are sampled while the test engine is operated using the appropriate test cycle on an engine dynamometer. The