

§ 7.88

30 CFR Ch. I (7-1-08 Edition)

(iv) The air inlet restriction shall be set within ± 10 percent of a recommended clean air filter at the engine operating condition giving maximum air flow as specified by the engine manufacturer to determine the concentration of NO_x as specified in paragraph (a)(6) of this section.

(4) The engine shall be at a steady-state condition when the exhaust gas samples are collected and other test data is measured.

(5) In a category A engine, 1.0 ± 0.1 percent CH_4 shall be injected into the engine's intake air.

(6) Operate the engine at several speed/torque conditions to determine the concentrations of CO and NO_x , dry basis, in the raw exhaust.

(b) *Acceptable performance.* The CO and NO_x concentrations in the raw exhaust shall not exceed the limits specified in § 7.84(b) throughout the specified operational range of the engine.

§ 7.88 Test to determine the gaseous ventilation rate.

The test shall be performed in the order listed in Table E-2. The test for determination of the particulate index described in § 7.89 may be done simultaneously with this test.

(a) *Test procedure.* (1) Couple the diesel engine to the dynamometer and attach the sampling and measurement devices specified in § 7.86.

(2) A minimum time of 10 minutes is required for each test mode.

(3) CO, CO_2 , NO_x , and CH_4 analyzers shall be zeroed and spanned at the analyzer range to be used prior to testing.

(4) Run the engine.

(i) The parameter for f_a shall be calculated in accordance with § 7.87(a)(3).

(ii) The air inlet and exhaust backpressure restrictions on the engine

shall be set as specified in §§ 7.87(a)(3) (iii) and (iv).

(5) The engine shall be at a steady-state condition before starting the test modes.

(i) The output from the gas analyzers shall be measured and recorded with exhaust gas flowing through the analyzers a minimum of the last three (3) minutes of each mode.

(ii) To evaluate the gaseous emissions, the last 60 seconds of each mode shall be averaged.

(iii) A 1.0 ± 0.1 percent CH_4 , by volume, shall be injected into the engine's intake air for category A engines.

(iv) The engine speed and torque shall be measured and recorded at each test mode.

(v) The data required for use in the gaseous ventilation calculations specified in paragraph (a)(9) of this section shall be measured and recorded at each test mode.

(6) Operate the engine at each rated speed and horsepower rating requested by the applicant according to Table E-2 in order to measure the raw exhaust gas concentration, dry basis, of CO, CO_2 , NO, and NO_2 , and CH_4 - exhaust (category A engines only).

(i) Test speeds shall be maintained within ± 1 percent of rated speed or ± 3 RPM, whichever is greater, except for low idle which shall be within the tolerances established by the manufacturer.

(ii) The specified torque shall be held so that the average over the period during which the measurements are taken is within ± 2 percent of the maximum torque at the test speed.

(7) The concentration of CH_4 in the intake air shall be measured for category A engines.

TABLE E-2—GASEOUS TEST MODES

Speed	Rated speed				Intermediate speed			Low-idle speed
	100	75	50	10	100	75	50	
% Torque								0

(8) After completion of the test modes, the following shall be done:

(i) Zero and span the analyzers at the ranges used during the test.

(ii) The gaseous emission test shall be acceptable if the difference in the zero and span results taken before the test and after the test are less than 2 percent.

(9) The gaseous ventilation rate for each exhaust gas contaminant shall be calculated as follows—

(i) The following abbreviations shall apply to both category A and category B engine calculations as appropriate:

- cfm—Cubic feet per min (ft³/min)
- Exh—Exhaust
- A—Air (lbs/hr)
- H—Grains of water per lb. of dry intake air
- J—Conversion factor
- m—Mass flow rate (mass/hr)
- TI—Intake air temperature (°F)
- PCAir—Percent Air
- PCCH₄—Percent CH₄ (intake air)
- UCH₄—Unburned CH₄
- PCECH₄—Percent Exhaust CH₄

(ii) Exhaust gas flow calculation for category B engines shall be (m Exh)=(A)+(m fuel).

(iii) Fuel/air ratio for category B engines shall be (f/a)=(m fuel) / (A).

(iv) Methane flow through category A engines shall be determined by the following:

$$\begin{aligned} \text{PCAir} &= 100 - \text{PCCH}_4 \\ Y &= (\text{PCAir})(0.289) + (\text{PCCH}_4)(0.16) \\ Z &= (0.16)(\text{PCCH}_4) + Y \\ \text{mCH}_4 &= (A)(Z) + (1 - Z) \end{aligned}$$

(v) Exhaust gas flow calculation for category A engines shall be (m Exh)=(A)+(m fuel)+(m CH₄)

(vi) Unburned CH₄ (lbs/hr) calculation for category A engines shall be mUCH₄=(m Exh)(0.0052)(PCECH₄)

(vii) Fuel/air ratio for category A engines shall be (f/a)=((m fuel)+(m CH₄)) - (m UCH₄)+(A)

(viii) Conversion from dry to wet basis for both category A and category B engines shall be:

$$\begin{aligned} (\text{NO wet basis}) &= (\text{NO dry basis})(J) \\ (\text{NO}_2 \text{ wet basis}) &= (\text{NO}_2 \text{ dry basis})(J) \\ (\text{CO}_2 \text{ wet basis}) &= (\text{CO}_2 \text{ dry basis})(J) \\ (\text{CO wet basis}) &= (\text{CO dry basis})(10^{-4})(J) \end{aligned}$$

Where:

$$J = (f/a)(-1.87) + (1 - (0.00022)(H))$$

(ix) NO and NO₂ correction for humidity and temperature for category A and category B engines shall be:

$$\begin{aligned} (\text{NO corr}) &= (\text{NO wet basis}) + (E) \\ (\text{NO}_2 \text{ corr}) &= (\text{NO}_2 \text{ wet basis}) + (E) \end{aligned}$$

Where:

$$\begin{aligned} E &= 1.0 + (R)(H - 75) + (G)(TI - 77) \\ R &= (f/a)(0.044) - (0.0038) \\ G &= (f/a)(-0.116) + (0.0053) \end{aligned}$$

(x) The calculations to determine the m of each exhaust gas contaminant in grams per hour at each test point shall be as follows for category A and category B engines:

$$\begin{aligned} (\text{m NO}) &= (\text{NO corr})(0.000470)(\text{m Exh}) \\ (\text{m NO}_2) &= (\text{NO}_2 \text{ corr})(0.000720)(\text{m Exh}) \\ (\text{m CO}_2) &= (\text{CO}_2 \text{ wet basis})(6.89)(\text{m Exh}) \\ (\text{m CO}) &= (\text{CO wet basis})(4.38)(\text{m Exh}) \end{aligned}$$

(xi) The calculations to determine the ventilation rate for each exhaust gas contaminant at each test point shall be as follows for category A and category B engines:

$$\begin{aligned} (\text{cfm NO}) &= (\text{m NO})(K) \\ (\text{cfm NO}_2) &= (\text{m NO}_2)(K) \\ (\text{cfm CO}_2) &= (\text{m CO}_2)(K) \\ (\text{cfm CO}) &= (\text{m CO})(K) \end{aligned}$$

Where:

$$K = 13,913.4 / (\text{pollutant grams/mole}) (\text{pollutant dilution value specified in § 7.84(c)}).$$

(b) The gaseous ventilation rate for each requested rated speed and horsepower shall be the highest ventilation rate calculated in paragraph (a)(9)(xi) of this section.

(1) Ventilation rates less than 20,000 cfm shall be rounded up to the next 500 cfm.

Example: 10,432 cfm shall be listed 10,500 cfm.

(2) Ventilation rates greater than 20,000 cfm shall be rounded up to the next 1,000 cfm.

Example: 26,382 cfm shall be listed 27,000 cfm.

[61 FR 55504, Oct. 25, 1996; 62 FR 34640, June 27, 1997]

§ 7.89 Test to determine the particulate index.

The test shall be performed in the order listed in Table E-3.

(a) *Test procedure.* (1) Couple the diesel engine to the dynamometer and connect the sampling and measurement devices specified in § 7.86.

(2) A minimum time of 10 minutes is required for each measuring point.

(3) Prior to testing, condition and weigh the particulate filters as follows:

(i) At least 1 hour before the test, each filter (pair) shall be placed in a