COSMOS
Navigate the Compliance Universe

40 C.F.R. § 600.113-12

Fuel economy, CO2 emissions, and carbon-related exhaust emission calculations for FTP, HFET, US06, SC03 and cold temperature FTP tests.

The Administrator will use the calculation procedure set forth in this section for all official EPA testing of vehicles fueled with gasoline, diesel, alcohol-based or natural gas fuel. The calculations of the weighted fuel economy and carbon-related exhaust emission values require input of the weighted grams/mile values for total hydrocarbons (HC), carbon monoxide (CO), and carbon dioxide (CO_2); and, additionally for methanol-fueled automobiles, methanol (CH_3OH) and formaldehyde (HCHO); and, additionally for ethanol-fueled automobiles, methanol (CH_3OH), ethanol (C_2H_5OH), acetaldehyde (C_2H_4O), and formaldehyde (HCHO); and additionally for natural gas-fueled vehicles, non-methane hydrocarbons (NMHC) and methane (CH_4). For manufacturers selecting the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818 of this chapter the calculations of the carbon-related exhaust emissions require the input of grams/mile values for nitrous oxide (N_2O) and methane (CH_4). Emissions shall be determined for the FTP, HFET, US06, SC03, and cold temperature FTP tests. Additionally, the specific gravity, carbon weight fraction and net heating value of the test fuel must be determined. The FTP, HFET, US06, SC03, and cold temperature FTP fuel economy and carbon-related exhaust emission values shall be calculated as specified in this section. An example fuel economy calculation appears in appendix II to this part.

(a) Calculate the FTP fuel economy as follows:

(1) Calculate the weighted grams/mile values for the FTP test for CO_2, HC, and CO, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC, N_2O, and CH_4 as specified in 40 CFR 1066.605. Measure and record the test fuel's properties as specified in paragraph (f) of this section.

(2) Calculate separately the grams/mile values for the cold transient phase, stabilized phase and hot transient phase of the FTP test. For vehicles with more than one source of propulsion energy, one of which is a rechargeable energy storage system, or vehicles with special features that the Administrator determines may have a rechargeable energy source, whose charge can vary during the test, calculate separately the grams/mile values for the cold transient phase, stabilized phase, hot transient phase and hot stabilized phase of the FTP test.

(b) Calculate the HFET fuel economy as follows:

(1) Calculate the mass values for the highway fuel economy test for HC, CO, and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC, N_2O, and CH_4 as specified in 40 CFR 1066.605. Measure and record the test fuel's properties as specified in paragraph (f) of this section.

(2) Calculate the grams/mile values for the highway fuel economy test for HC, CO, and CO_2, and where

applicable CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC, N_2O, and CH_4 by dividing the mass values obtained in paragraph (b)(1) of this section, by the actual driving distance, measured in miles, as specified in 40 CFR 1066.840.

(c) Calculate the cold temperature FTP fuel economy as follows:

(1) Calculate the weighted grams/mile values for the cold temperature FTP test for HC, CO, and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC, N_2O, and CH_4 as specified in 40 CFR 1066.605.

(2) Calculate separately the grams/mile values for the cold transient phase, stabilized phase and hot transient phase of the cold temperature FTP test as specified in 40 CFR 1066.605.

(3) Measure and record the test fuel's properties as specified in paragraph (f) of this section.

(d) Calculate the US06 fuel economy as follows:

(1) Calculate the total grams/mile values for the US06 test for HC, CO, and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC, N_2O, and CH_4 as specified in 40 CFR 1066.605.

(2) Calculate separately the grams/mile values for HC, CO, and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC, N_2O, and CH_4, for both the US06 City phase and the US06 Highway phase of the US06 test as specified in 40 CFR 1066.605 and 1066.831. In lieu of directly measuring the emissions of the separate city and highway phases of the US06 test according to the provisions of 40 CFR 1066.831, the manufacturer may optionally, with the advance approval of the Administrator and using good engineering judgment, analytically determine the grams/mile values for the city and highway phases of the US06 test. To analytically determine US06 City and US06 Highway phase emission results, the manufacturer shall multiply the US06 total grams/mile values determined in paragraph (d)(1) of this section by the estimated proportion of fuel use for the city and highway phases relative to the total US06 fuel use. The manufacturer may estimate the proportion of fuel use for the US06 City and US06 Highway phases by using modal CO_2, HC, and CO emissions data, or by using appropriate OBD data (*e.g.,* fuel flow rate in grams of fuel per second), or another method approved by the Administrator.

(3) Measure and record the test fuel's properties as specified in paragraph (f) of this section.

(e) Calculate the SC03 fuel economy as follows:

(1) Calculate the grams/mile values for the SC03 test for HC, CO, and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC, N_2O, and CH_4 as specified in 40 CFR 1066.605.

(2) Measure and record the test fuel's properties as specified in paragraph (f) of this section.

(f) Analyze and determine fuel properties as follows:

(1) Gasoline test fuel properties shall be determined by analysis of a fuel sample taken from the fuel supply. A sample shall be taken after each addition of fresh fuel to the fuel supply. Additionally, the fuel shall be resampled once a month to account for any fuel property changes during storage. Less frequent resampling may be permitted if EPA concludes, on the basis of manufacturer-supplied data, that the properties of test fuel in the manufacturer's storage facility will remain stable for a period longer than one month. The fuel samples shall be analyzed to determine fuel properties as follows for neat gasoline (E0) and for a low-level ethanol-

gasoline blend (E10):

(i) *Specific gravity.* Determine specific gravity using ASTM D4052 (incorporated by reference, see § 600.011). Note that ASTM D4052 refers to specific gravity as relative density.

(ii) *Carbon mass fraction.* (A) For E0, determine hydrogen mass percent using ASTM D3343 (incorporated by reference, see § 600.011), then determine carbon mass fraction as $CMF = 1 - 0.01 \times$ hydrogen mass percent.

(B) For E10, determine carbon mass fraction of test fuel, CMF_f, using the following equation, rounded to three decimal places:

$$CMF_f = VF_e \cdot \frac{SG_e}{SG_f} \cdot CMF_e + \left(1 - VF_e \cdot \frac{SG_e}{SG_f}\right) \cdot CMF_h$$

Where: VF_e = volume fraction of ethanol in the test fuel as determined from ASTM D4815 or ASTM D5599 (both incorporated by reference, see § 600.011). Calculate the volume fraction by dividing the volume percent of ethanol by 100. SG_e = specific gravity of pure ethanol. Use $SG_e = 0.7939$. SG_f = specific gravity of the test fuel as determined by ASTM D1298 or ASTM D4052 (both incorporated by reference, see § 600.011). CMF_e = carbon mass fraction of pure ethanol. Use $CMF_e = 0.5214$. CMF_h = carbon mass fraction of the hydrocarbon fraction of the test fuel as determined using ASTM D3343 (incorporated by reference, see § 600.011) with the following inputs, using V_{Tier3} or V_{LEVIII} as appropriate:

A = aromatics content of the hydrocarbon fraction $= \frac{VP_{aro,f}}{1 - VF_e}$.

G = API gravity of the hydrocarbon fraction $= \frac{141.5}{SG_h} - 131.5$.

V_{Tier3} = average volatility of the hydrocarbon fraction for EPA's E10 test fuel.

$$V_{Tier3} = \frac{T_{10} + T_{50} + T_{90}}{3} + 14.8.$$

V_{LEVIII} = average volatility of the LEV III hydrocarbon fraction.

$$V_{LEVIII} = \frac{T_{10} + T_{50} + T_{90}}{3} + 11.8.$$

Where: $VP_{aro,f}$ = volume percent aromatics in the test fuel as determined by ASTM D1319 (incorporated by reference, see § 600.011). An acceptable alternative method is ASTM D5769 (incorporated by reference, see § 600.011), as long as the result is bias-corrected as described in ASTM D1319.

SG_h = specific gravity of the hydrocarbon fraction $= \frac{SG_f - SG_e \cdot VF_e}{1 - VF_e}$.

T_{10}, T_{50}, T_{90} = the 10, 50, and 90 percent distillation temperatures of the test fuel, respectively, in degrees Fahrenheit, as determined by ASTM D86 (incorporated by reference, see § 600.011).

(iii) *Net heat of combustion.* (A) For E0, determine net heat of combustion in MJ/kg using ASTM D3338/D3338M (incorporated by reference, see § 600.011).