

based on the "1995 Formulation for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use", issued by The International Association for the Properties of Water and Steam (IAPWS). However, this approximation should only be used as prescribed in this section because it is an exponential fit that is accurate for data at 25 °C ±10 °C. Then, assuming a diesel fuel atomic hydrogen to carbon ratio of 1.8, and an intake and dilution air humidity of 75 grains (10.71 g<sub>water</sub>/kg<sub>dry air</sub> or 54.13 percent RH at 25 °C and 101.3 kPa),

(B) Calculate the maximum percent water vapor expected during testing; as  $\%H_2O_{exp} = (0.90 \times \%CO_2) + 1.69$ .  $\%CO_2$  is the value measured during the  $\%CO_2$  quench check.

(C) Calculate the expected wet concentration of NO in ppm; as  $NO_{exp} = NO_{dry} \times (1.00 - H_2O_{vol})$

(iv) Calculate the percent water vapor quench as:

$$\%H_2O_{quench} = ((NO_{exp} - NO_{wet})/NO_{exp}) \times (\%H_2O_{exp}/H_2O_{vol})$$

(3) Add the  $\%CO_{2quench}$  and the  $\%H_2O_{quench}$  values. Their sum may not exceed the limit set in paragraph (d). If their sum is greater than this limit, then the CLD instrument may not be used to perform testing unless it is repaired. The analyzer must be shown to pass this quench check after the repair before it may be used for testing.

[66 FR 5182, Jan. 18, 2001]

#### § 86.1324-84 Carbon dioxide analyzer calibration.

Prior to its introduction into service and monthly thereafter, the NDIR carbon dioxide analyzer shall be calibrated as follows:

(a) Follow good engineering practices for instrument start-up and operation. Adjust the analyzer to optimize performance.

(b) Zero the carbon dioxide analyzer with either zero-grade air or zero-grade nitrogen.

(c) Calibrate on each used operating range with a minimum of 6, approximately equally spaced, carbon dioxide-in-N<sub>2</sub> calibration or span gases (e.g., 15, 30, 45, 60, 75, and 90 percent of that range). For each range calibrated, if the deviation from a least-squares best-

fit straight line is within ±2 percent or less of the value at each non-zero data point and within ±0.3 percent of full scale on the zero data point, then concentration values may be calculated by using the linear calibration equation for that range. If the deviation exceeds these limits, then the best-fit non-linear equation which represents the data within these limits shall be used to determine concentration values.

(d) The initial and periodic interference, system check, and calibration test procedures specified in 40 CFR part 86, subpart D, may be used in lieu of the procedures in this section.

[48 FR 52210, Nov. 16, 1983, as amended at 62 FR 47129, Sept. 5, 1997]

#### § 86.1325-94 Methane analyzer calibration.

Prior to introduction into service and monthly thereafter, the methane analyzer shall be calibrated:

(a) Follow the manufacturer's instructions for instrument startup and operation. Adjust the analyzer to optimize performance.

(b) Zero the methane analyzer with zero-grade air.

(c) Calibrate on each used operating range with a minimum of 6, approximately equally spaced, CH<sub>4</sub> in air calibration gases (e.g., 15, 40, 45, 60, 75, and 90 percent of that range). For each range calibrated, if the deviation from a least-squares best-fit straight line is within ±2 percent of the value at each non-zero data point and within ±0.3 percent of full scale on the zero data point, then concentration values may be calculated by using the linear calibration equation for that range. If the deviation exceeds these limits, then the best-fit non-linear equation which represents the data within these limits shall be used to determine concentration values.

[59 FR 48531, Sept. 21, 1994, as amended at 62 FR 47129, Sept. 5, 1997]

#### § 86.1326-90 Calibration of other equipment.

Other test equipment used for testing shall be calibrated as often as required by the manufacturer or as necessary according to good practice. Specific equipment requiring calibration is the

gas chromatograph and flame ionization detector used in measuring methanol and the high pressure liquid chromatograph (HPLC) and ultraviolet detector for measuring formaldehyde.

[54 FR 14596, Apr. 11, 1989]

**§ 86.1327-96 Engine dynamometer test procedures; overview.**

(a) The engine dynamometer test procedure is designed to determine the brake specific emissions of hydrocarbons, nonmethane hydrocarbons, carbon monoxide, oxides of nitrogen, particulate, methanol and formaldehyde, as applicable. The test procedure consists of a "cold" start test following either natural or forced cool-down periods described in §§ 86.1334 and 86.1335, respectively. A "hot" start test follows the "cold" start test after a hot soak of 20 minutes. The idle test of subpart P of this part may be run after the "hot" start test. The exhaust emissions are diluted with ambient air and a continuous proportional sample is collected for analysis during both the cold- and hot-start tests. The composite samples collected are analyzed either in bags or continuously for hydrocarbons (HC), methane (CH<sub>4</sub>) carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), and oxides of nitrogen (NO<sub>x</sub>), or in sample collection impingers for methanol (CH<sub>3</sub>OH) and sample collection impingers (or cartridges) for formaldehyde (HCHO), as applicable. Measurement of CH<sub>3</sub>OH and HCHO may be omitted for 1990 through 1994 model year methanol-fueled engines when a FID calibrated on methanol is used. A bag or continuous sample of the dilution air is similarly analyzed for background levels of hydrocarbon, carbon monoxide, carbon dioxide, and oxides of nitrogen and, if appropriate, methane and/or methanol and/or formaldehyde. In addition, for diesel-cycle engines, particulates are collected on fluorocarbon-coated glass fiber filters or fluorocarbon-based (membrane) filters, and the dilution air may be prefiltered.

(b) Engine torque and rpm command set points shall be issued at 5 (10 Hz recommended) Hz or greater during both the cold and hot start tests. Feedback engine torque and rpm shall be recorded at least once every second during the test.

(c) Using the torque and rpm feedback signals, integrate the brake horsepower with respect to time for the cold and hot cycles. This produces a brake horsepower-hour value that enables the brake-specific emissions to be determined (see §§ 86.1342 and 86.1343).

(d)(1) When an engine is tested for exhaust emissions or is operated for service accumulation on an engine dynamometer, the complete engine shall be tested, with all emission control devices installed and functioning.

(2) For gasoline- and methanol-fueled engines, evaporative emission canisters must be loaded with fuel vapors and connected to the engine. The canisters used for testing must be of the same design as those used in engine applications.

(3) On air-cooled engines, the fan shall be installed.

(4) Additional accessories (e.g., oil cooler, alternators, air compressors, etc.) may be installed or their loading simulated if typical of the in-use application.

(5) The engine may be equipped with a production-type starter.

(e) Means of engine cooling that will maintain the engine operating temperatures (e.g., temperatures of intake air, oil, water, etc.) at approximately the same temperature as specified by the manufacturer shall be used. An auxiliary fan(s) may be used to maintain engine cooling during operation on the dynamometer. Rust inhibitors and lubrication additives may be used, up to the levels recommended by the additive manufacturer. Antifreeze mixtures and other coolants typical of those approved for use by the manufacturer may be used.

(f) *Exhaust system.* The exhaust system term shall meet the following requirements:

(1) *Gasoline-fueled and methanol-fueled Otto-cycle engines.* A chassis-type exhaust system shall be used. For all catalyst systems, the distance from the exhaust manifold flange(s) to the catalyst shall be the same as in the vehicle configuration unless the manufacturer provides data showing equivalent performance at another location. The catalyst container may be removed during all test sequences prior to the practice cycle, and replaced with an equivalent