

inlet pressure. With this set of calibration data, calculated the following CFV pressure ratio limit,  $Pr_{\text{ratio-lim}}$ :

$$Pr_{\text{ratio-lim}} = \frac{P_{\text{out-cal}}}{P_{\text{in-cal}}}$$

Where:

$P_{\text{in-cal}}$  = Venturi inlet pressure (PPI in absolute pressure units), and

$P_{\text{out-cal}}$  = Venturi outlet pressure (PPO in absolute pressure units), measured at the exit of the venturi diffuser outlet.

(B) The venturi pressure ratio ( $Pr_{\text{ratio-i}}$ ) during all emissions tests must be less than, or equal to, the calibration pressure ratio limit ( $Pr_{\text{ratio-lim}}$ ) derived from the CFV calibration data, such that:

$$\frac{P_{\text{out-i}}}{P_{\text{in-i}}} = Pr_{\text{ratio-i}} \leq Pr_{\text{ratio-lim}}$$

Where:

$P_{\text{in-i}}$  and  $P_{\text{out-i}}$  are the venturi inlet and outlet pressures, in absolute pressure units, at each  $i$ -th interval during the emissions test.

(ii) *Option 2. Other methods:* With prior Administrator approval, any other method may be used that assure that the venturi operates at sonic conditions during emissions tests, provided the method is based upon sound engineering principles.

(c) *CVS System Verification.* The following "gravimetric" technique can be used to verify that the CVS and analytical instruments can accurately measure a mass of gas that has been injected into the system. If the CVS and analytical system will be used only in the testing of petroleum-fueled engines, the system verification may be performed using either propane or carbon monoxide. If the CVS and analytical system will be used with methanol-fueled vehicles as well as petroleum-fueled vehicles, system verification performance check must include a methanol check in addition to either the propane or carbon monoxide check. (Verification can also be accomplished by constant flow metering using critical flow orifice devices.)

(1) Obtain a small cylinder that has been charged with pure propane or carbon monoxide gas (CAUTION—carbon monoxide is poisonous).

(2) Determine a reference cylinder weight to the nearest 0.01 grams.

(3) Operate the CVS in the normal manner and release a quantity of pure propane or carbon monoxide into the system during the sampling period (approximately 5 minutes).

(4) Following completion of step (3) in this paragraph (c) (if methanol injection is required), continue to operate the CVS in the normal manner and release a known quantity of pure methanol (in gaseous form) into the system during the sampling period (approximately five minutes). This step does not need to be performed with each verification, provided that it is performed at least twice annually.

(5) The calculations of § 86.144 are performed in the normal way, except in the case of propane. The density of propane (17.30 g/ft<sup>3</sup>/carbon atom (0.6109 kg/m<sup>3</sup>/carbon atom)) is used in place of the density of exhaust hydrocarbons. In the case of carbon monoxide, the density of 32.97 g/ft<sup>3</sup> (1.164 kg/m<sup>3</sup>) is used. In the case of methanol, the density of 37.71 g/ft<sup>3</sup> (1.332 kg/m<sup>3</sup>) is used.

(6) The gravimetric mass is subtracted from the CVS measured mass and then divided by the gravimetric mass to determine the percent accuracy of the system.

(7) The cause for any discrepancy greater than ±2 percent must be found and corrected. (For 1991–1995 calendar years, discrepancies greater than ±2 percent are allowed for the methanol test, provided that they do not exceed ±8 percent for 1991 testing or ±6 percent for 1992–1995 testing.)

[54 FR 14518, Apr. 11, 1989, as amended at 60 FR 34344, June 30, 1995; 62 FR 47121, Sept. 5, 1997; 63 FR 24448, May 4, 1998; 65 FR 8278, Feb. 18, 2000]

**§ 86.120-94 Gas meter or flow instrumentation calibration; particulate, methanol and formaldehyde measurement.**

(a) Sampling for particulate, methanol and formaldehyde emissions requires the use of gas meters or flow instrumentation to determine flow through the particulate filters, methanol impingers and formaldehyde impingers. These instruments shall receive initial and periodic calibrations as follows:

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(1)(i) Install a calibration device in series with the instrument. A critical flow orifice, a bellmouth nozzle, a laminar flow element or an NBS traceable flow calibration device is required as the standard device.

(ii) The flow system should be checked for leaks between the calibration and sampling meters, including any pumps that may be part of the system, using good engineering practice.

(2) Flow air through the calibration system at the sample flow rate used for particulate, methanol, and formaldehyde testing and at the backpressure which occurs during the test.

(3) When the temperature and pressure in the system have stabilized, measure the indicated gas volume over a time period of at least five minutes or until a gas volume of at least  $\pm 1$  percent accuracy can be determined by the standard device. Record the stabilized air temperature and pressure upstream of the instrument and as required for the standard device.

(4) Calculate air flow at standard conditions as measured by both the standard device and the instrument(s). (Standard conditions are defined as 68 °F (20 °C) and 29.92 in Hg (101.3 kPa).)

(5) Repeat the procedures of paragraphs (a)(2) through (4) of this section using at least two flow rates which bracket the typical operating range.

(6) If the air flow at standard conditions measured by the instrument differs by  $\pm 1.0$  percent of the maximum operating range or  $\pm 2.0$  percent of the point (whichever is smaller), then a correction shall be made by either of the following two methods:

(i) Mechanically adjust the instrument so that it agrees with the calibration measurement at the specified flow rates using the criteria of paragraph (a)(6) of this section; or

(ii) Develop a continuous best fit calibration curve for the instrument (as a function of the calibration device flow measurement) from the calibration points to determine corrected flow. The points on the calibration curve relative to the calibration device measurements must be within  $\pm 1.0$  percent of the maximum operating range or  $\pm 2.0$  percent of the point (whichever is smaller).

(b) Other systems. A bell prover may be used to calibrate the instrument if the procedure outlined in ANSI B109.1-1973 is used. Prior approval by the Administrator is not required to use the bell prover.

[60 FR 34344, June 30, 1995]

### § 86.121-90 Hydrocarbon analyzer calibration.

The hydrocarbon analyzers shall receive the following initial and periodic calibration. The HFID used with petroleum-fueled diesel vehicles shall be operated at a temperature of  $375 \text{ °F} \pm 10 \text{ °F}$  ( $191 \text{ °C} \pm 6 \text{ °C}$ ). The HFID used with methanol-fueled vehicles shall be operated at  $235 \text{ °F} \pm 15 \text{ °F}$  ( $113 \pm 8 \text{ °C}$ ).

(a) *Initial and periodic optimization of detector response.* Prior to its introduction into service and at least annually thereafter, the FID and HFID hydrocarbon analyzers shall be adjusted for optimum hydrocarbon response. Alternate methods yielding equivalent results may be used, if approved in advance by the Administrator.

(1) Follow the manufacturer's instructions or good engineering practice for instrument startup and basic operating adjustment using the appropriate FID fuel and zero-grade air.

(2) Optimize on the most common operating range. Introduce into the analyzer a propane (methane as appropriate) in air mixture (methanol in air mixture for methanol-fueled vehicles when optional methanol calibrated HFID procedure is used during the 1994 model year) with a propane (or methane or methanol as appropriate) concentration equal to approximately 90 percent of the most common operating range.

(3) One of the following is required for FID or HFID optimization:

(i) For all FIDs and HFIDs, the procedures specified by the applicable FID or HFID manufacturer.

(ii) For Beckman 400 FIDs only, implementation of the recommendations outlined in Society of Automotive Engineers (SAE) paper No. 770141, "Optimization of Flame Ionization Detector for Determination of Hydrocarbons in Diluted Automobile Exhaust"; author, Glenn D. Reschke.

(iii) For HFIDs only, the following peaking procedure. (A) With the fuel