

**§ 90.420 CVS concept of exhaust gas sampling system.**

(a) A dilute exhaust sampling system is designed to directly measure the true mass of emissions in engine exhaust without the necessity of measuring either fuel flow or intake air flow. This is accomplished by diluting the exhaust produced by a test engine with ambient background air and measuring the total diluted exhaust flow rate and the concentration of emissions within the dilute flow. Total mass flow of an emission is then easily calculated.

(b) A constant volume sampler (CVS) is typically used to control the total amount of dilute flow through the system. As the name implies, a CVS restricts flow to a known value dependent only on the dilute exhaust temperature and pressure.

(c) For the testing described in this subpart, a CVS must consist of: a mixing tunnel into which the engine exhaust and dilutant (background) air are dumped; a dilute exhaust flow metering system; a dilute exhaust sample port; a background sample port; a dilute exhaust sampling system; and a background sampling system.

(1) *Mixing tunnel.* The mixing tunnel must be constructed such that complete mixing of the engine exhaust and background air is assured prior to the sampling probe.

(2) *Exhaust flow metering system.* A dilute exhaust flow metering system must be used to control the total flow rate of the dilute engine exhaust as described in § 90.421.

(3) *Exhaust sample port.* A dilute exhaust sample port must be located in or downstream of the mixing tunnel at a point where complete mixing of the engine exhaust and background air is assured.

(4) *Background sample port.* A dilute exhaust sample port must be located in the stream of background air before it is mixed with the engine exhaust. The background probe must draw a representative sample of the background air during each sampling mode.

(5) *Exhaust sampling system.* The dilute exhaust sampling system controls the flow of samples from the mixing tunnel to the analyzer system. This could be either a continuous sampling

system or grab (bag) sampling system. If a critical flow venturi (CFV) is used on the dilute exhaust sample probe, this system must assure that the sample CFV is in choke flow during testing. If no CFV is used, this system must assure a constant volumetric flow rate through the dilute exhaust sample probe or must incorporate electronic flow compensation.

(6) *Background sampling system.* The background sampling system controls the flow of samples from the background air supply to the analyzer system. This could be either a continuous sampling system or grab (bag) sampling system. This system must assure a constant volumetric flow rate through the background sample probe.

**§ 90.421 Dilute gaseous exhaust sampling and analytical system description.**

(a) *General.* The exhaust gas sampling system described in this section is designed to measure the true mass of gaseous emissions in the exhaust of nonroad small spark-ignition engines. This system utilizes the Constant Volume Sampling (CVS) concept (described in § 90.420) of measuring mass emissions of HC, NO<sub>x</sub>, CO, and CO<sub>2</sub>. Grab sampling for individual modes is an acceptable method of dilute testing for all constituents, HC, NO<sub>x</sub>, CO, and CO<sub>2</sub>. Continuous dilute sampling is not required for any of the exhaust constituents, but is allowable for all. Heated sampling is not required for any of the constituents, but is allowable for HC and NO<sub>x</sub>. The mass of gaseous emissions is determined from the sample concentration and total flow over the test period. As an option, the measurement of total fuel mass consumed over a cycle may be substituted for the exhaust measurement of CO<sub>2</sub>. General requirements are as follows:

(1) This sampling system requires the use of a Positive Displacement Pump—Constant Volume Sampler (PDP-CVS) system with a heat exchanger, or a Critical Flow Venturi—Constant Volume Sampler (CFV-CVS) system with CFV sample probes and/or a heat exchanger or electronic flow compensation. Figure 2 in Appendix B of this subpart is a schematic drawing of the PDP-CVS system. Figure 3 in Appendix