pumps, and switches may be used to provide additional information and coordinate the functions of the component systems. Other components, such as snubbers, which are not needed to maintain accuracy on some systems, may be excluded if their exclusion is based upon good engineering judgment.

(6) Other sampling and/or analytical systems may be used if shown to yield equivalent results and if approved in advance by the Administrator.

(b) *Component description.* The components necessary for exhaust 0sampling must meet the following requirements:

(1) *Exhaust dilution system.* The PDP– CVS must conform to all of the requirements listed for the exhaust gas PDP–CVS in § 90.420 of this chapter. The CFV–CVS must conform to all of the requirements listed for the exhaust gas CFV–CVS in § 90.420 of this chapter. In addition, the CVS must conform to the following requirements:

(i) The flow capacity of the CVS must be sufficient to maintain the diluted exhaust stream in the dilution system at a temperature of 190° C or less at the sampling zone for hydrocarbon measurement and as required to prevent condensation at any point in the dilution system. Gaseous emission samples may be taken directly from this sampling point.

(ii) For the CFV–CVS, either a heat exchanger or electronic flow compensation is required (see Figure 3 in Appendix B of this subpart).

(iii) For the CFV–CVS when a heat exchanger is used, the gas mixture temperature, measured at a point immediately ahead of the critical flow venturi, must be within  $\pm 11^{\circ}$  C of the average operating temperature observed during the test with the simultaneous requirement that condensation does not occur. The temperature measuring system (sensors and readout) must have an accuracy and precision of  $\pm 2^{\circ}$  C. For systems utilizing a flow compensator to maintain proportional flow, the requirement for maintaining constant temperature is not necessary.

(2) Continuous HC measurement system. (i) The continuous HC sample system (as shown in Figure 2 or 3 in Appendix B of this subpart) uses an "overflow" zero and span system. In this type of system, excess zero or span gas spills out of the probe when zero and span checks of the analyzer are made.

(ii) No other analyzers may draw a sample from the continuous HC sample probe, line, or system, unless a common sample pump is used for all analyzers and the sample line system design reflects good engineering practice. (iii) The overflow gas flow rates into the sample line must be at least 105 percent of the sample system flow rate.

(iv) The overflow gases must enter the sample line as close as practical to the outside surface of the CVS duct or dilution system.

(v) The continuous HC sampling system consists of a probe (which for a HFID analyzer must raise the sample to the specified temperature) and, where used, a sample transfer system (which for a HFID must maintain the specified temperature). The HFID continuous hydrocarbon sampling system (exclusive of the probe) must:

(A) Maintain a wall temperature of  $190^{\circ}$  C  $\pm 11^{\circ}$  C as measured at every separately controlled heated component (that is, filters, heated line sections), using permanent thermocouples located at each of the separate components.

(B) Have a wall temperature of  $190^{\circ}$  C  $\pm 11^{\circ}$  C over its entire length. The temperature of the system is demonstrated by profiling the thermal characteristics of the system where possible at initial installation and after any major maintenance performed on the system. The profiling is to be accomplished using the insertion thermocouple probing technique. The system temperature must be monitored continuously during testing at the locations and temperature described in § 90.421(b)(2).

(C) Maintain a gas temperature of  $190^{\circ}$  C  $\pm 11^{\circ}$  C immediately before the heated filter and HFID. Determine these gas temperatures by a temperature sensor located immediately upstream of each component.

(vi) The continuous hydrocarbon sampling probe:

(A) Is defined as the first 25.4 to 76.2 cm of the continuous hydrocarbon sampling system.

(B) Has a 0.483 cm minimum inside diameter.

(C) Is installed in the dilution system at a point where the dilution air and exhaust are well mixed and provide a homogenous mixture.

(D) Is sufficiently distant (radially) from other probes and the system wall so as to be free from the influence of any wakes or eddies.

(E) For a continuous HFID sample probe, the probe must increases the gas stream temperature to  $190^{\circ}$  C  $\pm 11^{\circ}$  C at the exit of the probe. Demonstrate the ability of the probe to accomplish this using the insertion thermocouple technique at initial installation and after any major maintenance. Demonstrate compliance with the temperature specification by continuously recording during each test the temperature of either the gas stream or the wall of the sample probe at its terminus.

(vii) The response time of the continuous measurement system must be taken into account when logging test data.

(3) *Sample Mixing*. (i) Configure the dilution system to ensure a well mixed, homogeneous sample prior to the sampling probe(s).

(ii) Make the temperature of the diluted exhaust stream inside the dilution system sufficient to prevent water condensation.

(iii) Direct the engine exhaust downstream at the point where it is introduced into the dilution system.

(4) Continuously integrated  $NO_X$ , CO, and CO<sub>2</sub> measurement systems.

(i) Sample probe requirements:

(A) The sample probe for continously intergrated  $NO_X$ , CO, and  $CO_2$  must be in the same plane as the continuous HC probe, but sufficiently distant (radially) from other probes and the tunnel wall so as to be free from the influences of any wakes or eddies.

(B) The sample probe for continously intergrated NO<sub>X</sub>, CO, and CO<sub>2</sub> must be heated and insulated over the entire length, to prevent water condensation, to a minimum temperature of 55° C. Sample gas temperature immediately before the first filter in the system must be at least 55° C.

(ii) Conform to the continuous  $NO_X$ , CO, or  $CO_2$  sampling and analysis system to the specifications of part 86, subpart D of this chapter with the following exceptions and revisions:

(A) Heat the system components requiring heating only to prevent water condensation, the minimum component temperature is 55° C.

(B) Coordinate analysis system response time with CVS flow fluctuations and sampling time/test cycle offsets, if necessary.

(C) Use only analytical gases conforming to the specifications of § 90.312 of this subpart for calibration, zero and span checks.

(D) Use a calibration curve conforming to  $\S$  90.321 for CO and CO<sub>2</sub> and  $\S$  90.318 for NO<sub>x</sub> for any range on a linear analyzer below 155 ppm.

(iii) Convert the chart deflections or voltage output of analyzers with nonlinear calibration curves to concentration values by the calibration curve(s) specified in § 90.321 of this chapter before flow correction (if used) and subsequent integration takes place.

## §90.422 Background sample.

(a) Background samples are produced by drawing a sample of the dilution air during the exhaust collection phase of each test cycle mode.