

§ 91.309

fuels specified under paragraph (b) of this section for engine service accumulation. Leaded fuel may not be used during service accumulation.

(2) The octane rating of the gasoline used may not be higher than 4.0 research octane numbers above the minimum recommended by the manufacturer and have a minimum sensitivity of 7.5 octane numbers, where sensitivity is defined as research octane number minus motor octane number.

(d) Other fuels may be used for testing provided:

(1) They are commercially viable,

(2) Information, acceptable to the Administrator, is provided to show that only the designated fuel would be used in customer service,

(3) Use of a fuel listed under paragraph (b) of this section would have a detrimental effect on emissions or durability; and

(4) The Administrator provides written approval of the fuel specifications prior to the start of testing.

§ 91.309 Engine intake air temperature measurement.

(a) Engine intake air temperature measurement must be made within 100 cm of the air-intake of the engine. The measurement location must be either in the supply system or in the air stream entering the engine.

(b) The temperature measurements must be accurate to within ±2 °C.

§ 91.310 Engine intake air humidity measurement.

This section refers to engines which are supplied with intake air other than the ambient air in the test cell (i.e., air which has been pumped directly to the engine air intake system). For engines which use ambient test cell air for the engine intake air, the ambient testcell humidity measurement may be used.

(a) Humidity conditioned air supply. Air that has had its absolute humidity altered is considered humidity-conditioned air. For this type of intake air supply, the humidity measurements must be made within the intake air supply system, and after the humidity conditioning has taken place.

(b) Unconditioned air supply. Humidity measurements in unconditioned intake air supply must be made in the in-

take air stream entering the engine. Alternatively, the humidity measurements can be measured within the intake air stream entering the supply system.

§ 91.311 Test conditions.

(a) General requirements. (1) Ambient temperature levels encountered by the test engine throughout the test sequence may not be less than 20 °C nor more than 30 °C.

(2) Calculate all volumes and volumetric flow rates at standard conditions for temperature and pressure. Use these conditions consistently throughout all calculations. Standard conditions for temperature and pressure are 25 °C and 101.3 kPa.

(b) Engine test conditions. Measure the absolute temperature (designated as T and expressed in Kelvin) of the engine air at the inlet to the engine and the dry atmospheric pressure (designated as p<sub>s</sub> and expressed in kPa. Determine the parameter f according to the following provisions:

(1) Naturally aspirated and mechanically supercharged engines:

$$f = \frac{99}{p_s} \times \left( \frac{T}{298} \right)^{0.7}$$

(2) Turbocharged engine with or without cooling of inlet air:

$$f = \left( \frac{99}{p_s} \right)^{0.7} \times \left( \frac{T}{298} \right)^{1.5}$$

(3) For a test to be recognized as valid, the parameter f must be between the limits as shown below:

$$0.96 < f < 1.04$$

§ 91.312 Analytical gases.

(a) The shelf life of a calibration gas may not be exceeded. Record the expiration date stated by the gas supplier for each calibration gas.

(b) Pure gases. The required purity of the gases is defined by the contamination limits given in parenthesis. The following gases must be available for operation.

## Environmental Protection Agency

## §91.313

(1) Purified nitrogen, also referred to as "zero-grade nitrogen" (Contamination  $\leq 1$  ppm C,  $\leq 1$  ppm CO,  $\leq 400$  ppm CO<sub>2</sub>,  $\leq 0.1$  ppm NO)

(2) Purified oxygen (Purity 99.5 percent vol O<sub>2</sub>)

(3) Hydrogen-helium mixture (40 $\pm$ 2 percent hydrogen, balance helium) (Contamination  $\leq 1$  ppm C,  $\leq 400$  ppm CO)

(4) Purified synthetic air, also referred to as "zero gas" (Contamination  $\leq 1$  ppm C,  $\leq 1$  ppm CO,  $\leq 400$  ppm CO<sub>2</sub>,  $\leq 0.1$  ppm NO) (Oxygen content between 18-21 percent vol.)

(c) *Calibration and span gases.* (1) Calibration gas values are to be derived from NIST "Standard Reference Materials" (SRM's) or other local gas standards and are to be single blends as specified in this subsection.

(2) Mixtures of gases having the following chemical compositions must be available:

C<sub>3</sub> H<sub>8</sub> and purified synthetic air (dilute measurements); C<sub>3</sub> H<sub>8</sub> and purified nitrogen (raw measurements);

CO and purified nitrogen;

NO<sub>x</sub> and purified nitrogen (the amount of NO<sub>2</sub> contained in this calibration gas must not exceed five percent of the NO content);

CO<sub>2</sub> and purified nitrogen.

NOTE: For the HFID or FID, the manufacturer may choose to use as a diluent span gas and the calibration gas either purified synthetic air or purified nitrogen. Any mixture of C<sub>3</sub> H<sub>8</sub> and purified synthetic air which contains a concentration of propane higher than what a gas supplier considers to be safe may be substituted with a mixture of C<sub>3</sub> H<sub>8</sub> and purified nitrogen. However, the manufacturer must be consistent in the choice of diluent (zero air or purified nitrogen) between the calibration and span gases. If a manufacturer chooses to use C<sub>3</sub> H<sub>8</sub> and purified nitrogen for the calibration gases, then purified nitrogen must be the diluent for the span gases.

(3) The true concentration of a span gas must be within  $\pm 2$  percent of the NIST gas standard. The true concentration of a calibration gas must be within  $\pm 1$  percent of the NIST gas standard. The use of precision blending devices (gas dividers) to obtain the required calibration gas concentrations is acceptable. Give all concentrations of calibration gas on a volume basis (volume percent or volume ppm).

(4) The gas concentrations used for calibration and span may also be ob-

tained by means of a gas divider, diluted with purified N<sub>2</sub> or with purified synthetic air. The accuracy of the mixing device must be such that the concentration of the diluted gases may be determined to within  $\pm 2$  percent.

(d) Oxygen interference check gases must contain propane with 350 ppmC  $\pm$  75 ppmC hydrocarbon. Determine the concentration value to calibration gas tolerances by chromatographic analysis of total hydrocarbons plus impurities or by dynamic blending. Use nitrogen as the predominant diluent with the balance oxygen.

(e) Fuel for the hydrocarbon flame ionization detector (HC-FID) must be a blend of 40 $\pm$ 2 percent hydrogen with the balance being helium. The mixture shall contain less than one ppm equivalent carbon response; 98 to 100 percent hydrogen fuel may be used with advance approval of the Administrator.

(f) *Hydrocarbon analyzer burner air.* The concentration of oxygen must be within one mole percent of the oxygen concentration of the burner air used in the latest oxygen interference check (percent O<sub>2</sub> I), see §91.316(d). If the difference in oxygen concentration is greater than one mole percent, then the oxygen interference must be checked and the analyzer adjusted if necessary, to meet the percent O<sub>2</sub> I requirements. The burner air must contain less than two ppmC hydrocarbon.

### §91.313 Analyzers required.

(a) *Analyzers.* Analyze measured gases with the following instruments:

(1) *Carbon monoxide (CO) analysis.* (i) The carbon monoxide analyzer must be of the non-dispersive infrared (NDIR) absorption type.

(ii) The use of linearizing circuits is permitted.

(2) *Carbon dioxide (CO<sub>2</sub>) analysis.* (i) The carbon dioxide analyzer must be of the non-dispersive infrared (NDIR) absorption type.

(ii) The use of linearizing circuits is permitted.

(3) *Oxygen (O<sub>2</sub>) analysis.* Oxygen (O<sub>2</sub>) analyzers may be of the paramagnetic (PMD), zirconia (ZRDO) or electrochemical type (ECS).

(4) *Hydrocarbon (HC) analysis.* (i) For Raw Gas Sampling, the hydrocarbon analyzer must be of the heated flame