

$$\% \text{ CO}_2 \text{ quench} = 100 \times \left( 1 - \frac{(c \times a)}{(d \times a) - (d \times b)} \right) \times (a/b)$$

Where:

- a = Undiluted CO<sub>2</sub> concentration (percent)
- b = Diluted CO<sub>2</sub> concentration (percent)
- c = Diluted NO concentration (ppm)
- d = Undiluted NO concentration (ppm)

(2) *NO<sub>x</sub> analyzer water quench check.*

(i) This check applies to wet measurements only. An NO span gas having a concentration of 80 percent to 100 percent of full scale of a normal operating range is passed through the CLD (or HCLD) and the response recorded as "D". The NO span gas is then bubbled through water at room temperature and passed through the CLD (or HCLD) and the analyzer's response recorded as AR. Determine and record the analyzer's absolute operating pressure and the bubbler water temperature. (It is important that the NO span gas contains minimal NO<sub>2</sub> concentration for this check. No allowance for absorption of NO<sub>2</sub> in water has been made in the following quench calculations.)

(ii) Calculations for water quench must consider dilution of the NO span gas with water vapor and scaling of the water vapor concentration of the mixture to that expected during testing. Determine the mixture's saturated vapor pressure (designated as P<sub>wb</sub>) that corresponds to the bubbler water temperature. Calculate the water concentration ("Z1", percent) in the mixture by the following equation:

$$Z1 = 100 \times \frac{P_{wb}}{GP}$$

where GP is the analyzer's standard operating pressure (pascals).

(iii) Calculate the expected dilute NO span gas and water vapor mixture concentration (designated as D1) by the following equation:

$$D1 = D \times \left( 1 - \frac{Z1}{100} \right)$$

**§ 90.326 Pre- and post-test analyzer calibration.**

Calibrate the range of each analyzer used during the engine exhaust emission test prior to and after each test in accordance with the following:

(a) Make the calibration by using a zero gas and a span gas. The span gas value must be between 75 percent and 100 percent of full scale, inclusive, of the measuring range.

(b) Use the same analyzer(s) flow rate and pressure as that used during exhaust emission test sampling.

(c) Warm-up and stabilize the analyzer(s) before the calibration is made.

(d) If necessary clean and/or replace filter elements before calibration is made.

(e) Calibrate analyzer(s) as follows:

(1) Zero the analyzer using the appropriate zero gas. Adjust analyzer zero if necessary. Zero reading should be stable.

(2) Span the analyzer using the appropriate span gas for the range being calibrated. Adjust the analyzer to the calibration set point if necessary.

(3) Re-check zero and span set points.

(4) If the response of the zero gas or span gas differs more than one percent of full scale, then repeat paragraphs (e) (1) through (3) of this section.

**§ 90.327 Sampling system requirements.**

(a) *Sample component surface temperature.* For sampling systems which use heated components, use engineering judgment to locate the coolest portion of each component (pump, sample line section, filters, and so forth) in the heated portion of the sampling system that has a separate source of power or heating element. Monitor the temperature at that location. If several components are within an oven, then only the surface temperature of the component with the largest thermal mass and the oven temperature need be measured.

(b) If water is removed by condensation, monitor the sample gas temperature or sample dew point either within

**Environmental Protection Agency**

**Pt. 90, Subpt. D, App. A**

the water trap or downstream. It may not exceed 7 °C.

**§ 90.328 Measurement equipment accuracy/calibration frequency table.**

(a) The accuracy of measurements must be such that the maximum tolerances shown in Table 2 in Appendix A of this subpart are not exceeded.

(b) All equipment and analyzers must be calibrated according to the frequencies shown in Table 2 in Appendix A of this subpart.

(c) Prior to initial use and after major repairs, bench check each analyzer (see § 90.323).

(d) Calibrate equipment as specified in § 90.306 and §§ 90.315 through 90.322.

(e) At least monthly, or after any maintenance which could alter calibration, perform the following calibrations and checks.

(1) Leak check the vacuum side of the system (see § 90.324(a)).

(2) Verify that the automatic data collection system (if used) meets the requirements found in Table 2 in Appendix A of this subpart.

(3) Check the fuel flow measurement instrument to insure that the specifications in Table 2 in Appendix A of this subpart are met.

(f) Verify that all NDIR analyzers meet the water rejection ratio and the CO<sub>2</sub> rejection ratio as specified in § 90.325.

(g) Verify that the dynamometer test stand and power output instrumenta-

tion meet the specifications in Table 2 in Appendix A of this subpart.

**§ 90.329 Catalyst thermal stress test.**

(a) *Oven characteristics.* The oven used for thermally stressing the test catalyst must be capable of maintaining a temperature of 500 ± 5 °C and 1000 ± 10 °C.

(b) *Evaluation gas composition.* (1) A synthetic exhaust gas mixture is used for evaluating the effect of thermal stress on catalyst conversion efficiency.

(2) The synthetic exhaust gas mixture must have the following composition:

Constituent	Volume percent	Parts per million
Carbon Monoxide .....	1	.....
Oxygen .....	1.3	.....
Carbon Dioxide .....	3.8	.....
Water Vapor .....	10	.....
Sulfur dioxide .....	.....	20
Oxides of nitrogen .....	.....	280
Hydrogen .....	.....	3500
Hydrocarbon* .....	.....	4000
Nitrogen = Balance		

\* Propylene/propane ratio = 2/1.

(c) *Phase 2 engines.* The catalyst thermal stress test is not required for engine families certified to the Phase 2 standards.

[60 FR 34598, July 3, 1995, as amended at 64 FR 15243, Mar. 30, 1999]

**APPENDIX A TO SUBPART D OF PART 90—TABLES**

**TABLE 1—SYMBOLS USED IN SUBPART D**

Symbol	Term	Unit
CO	Carbon monoxide.	
CO <sub>2</sub>	Carbon dioxide.	
NO	Nitric oxide.	
NO <sub>2</sub>	Nitrogen dioxide.	
NO <sub>x</sub>	Oxides of nitrogen.	
O <sub>2</sub>	Oxygen.	
conc	Concentration (ppm by volume) .....	ppm
f	Engine specific parameter considering atmospheric conditions.	
F <sub>FCB</sub>	Fuel specific factor for the carbon balance calculation.	
F <sub>FD</sub>	Fuel specific factor for exhaust flow calculation on dry basis.	
F <sub>FH</sub>	Fuel specific factor representing the hydrogen to carbon ratio.	
F <sub>FW</sub>	Fuel specific factor for exhaust flow calculation on wet basis.	
G <sub>AIRW</sub>	Intake air mass flow rate on wet basis .....	kg/h
G <sub>AIRD</sub>	Intake air mass flow rate on dry basis .....	kg/h
G <sub>EXHW</sub>	Exhaust gas mass flow rate on wet basis .....	kg/h
G <sub>FUEL</sub>	Fuel mass flow rate .....	kg/h
H	Absolute humidity (water content related to dry air) .....	gr/kg
i	Subscript denoting an individual mode.	
K <sub>H</sub>	Humidity correction factor.	
L	Percent torque related to maximum torque for the test mode .....	percent