Example calibration points (percent)	Acceptable for calibration?
20, 30, 40, 50, 60, 70	No, range covered is 50 percent, not 64 percent.
20, 30, 40, 50, 60, 70, 80, 90 ..	Yes.
10, 25, 40, 55, 70, 85	Yes.
10, 30, 50, 70, 90	No, though equally spaced and entire range covered, a minimum of six points is needed.

(5) Generate a calibration curve. The calibration curve must be of fourth order or less, have five or fewer coefficients, and be of the form of equation (1) or (2). Include zero as a data point. Compensation for known impurities in the zero gas can be made to the zero-data point. The calibration curve must fit the data points within 2 percent of point or one percent of full scale, whichever is less.

$$y = Ax^4 + Bx^3 + Cx^2 + Dx + E \qquad (1)$$

$$y = \frac{x}{Ax^4 + Bx^3 + Cx^2 + Dx + E} \qquad (2)$$

y=concentration
x=chart deflection

(6) Option. A new calibration curve need not be generated if:

(i) A calibration curve conforming to paragraph (b)(5) of this section exists;

(ii) The responses generated in paragraph (b)(4) of this section are within one percent of full scale or two percent of point, whichever is less, of the responses predicted by the calibration curve for the gases used in paragraph (b)(4) of this section.

(7) If multiple range analyzers are used, the lowest range used must meet the curve fit requirements below 15 percent of full scale.

(c) *Linear calibration criteria.* If any range is within 2 percent of being linear, a linear calibration may be used. To determine if this criterion is met:

(1) Perform a linear least-square regression on the data generated. Use an equation of the form y=mx, where x is the actual chart deflection and y is the concentration.

(2) Use the equation z=y/m to find the linear chart deflection (designated as z) for each calibration gas concentration (designated as y).

(3) Determine the linearity (designated as percent L) for each calibration gas by:

$$\text{percent } L = \frac{(zx)}{\text{Fullscale linear chart deflection}}(100)$$

(4) The linearity criterion is met if the percent L is less than ±2 percent for each data point generated. For each emission test, use a calibration curve of the form Y=mx. The slope (designated as m) is defined for each range by the spanning process.

§ 91.322 Calibration of other equipment.

Calibrate other test equipment as often as required by the manufacturer or as necessary according to good engineering practice.

§ 91.323 Analyzer bench checks.

(a) Prior to initial use and after major repairs, verify that each analyzer complies with the specifications given in Table 2 in appendix A to this subpart.

(b) If a stainless steel NO_2 to NO converter is used, condition all new or replacement converters. The conditioning consists of either purging the converter with air for a minimum of four hours or until the converter efficiency is greater than 90 percent. The converter must be at operational temperature while purging. Do not use this procedure prior to checking converter efficiency on in-use converters.

§ 91.324 Analyzer leakage check.

(a) *Vacuum side leak check.* (1) Check any location within the analysis system where a vacuum leak could affect the test results.

(2) The maximum allowable leakage rate on the vacuum side is 0.5 percent of the in-use flow rate for the portion

342

of the system being checked. The analyzer flows and bypass flows may be used to estimate the in-use flow rates.

(3) The sample probe and the connection between the sample probe and valve V2 (see Figure 1 in appendix B of this subpart) may be excluded from the leak check.

(b) *Pressure side leak check.* Substantial leaks of the sample on the pressure side of the system may impact sample integrity if the leaks are of sufficient magnitude. As a safety precaution, it is good engineering practice to perform periodic pressure side leak checks on the sampling system.

§ 91.325 Analyzer interference checks.

(a) Gases present in the exhaust other than the one being analyzed can interfere with the reading in several ways. Positive interference occurs in NDIR and PMD instruments when the interfering gas gives the same effect as the gas being measured, but to a lesser degree. Negative interference occurs in NDIR instruments by the interfering gas broadening the absorption band of the measured gas, and in CLD instruments by the interfering gas quenching the radiation. The interference checks described in this section are to be made initially and after any major repairs that could affect analyzer performance.

(b) CO analyzer water and CO_2 interference checks. Bubble through water at room temperature a CO_2 span gas having a concentration of between 80 percent and 100 percent inclusive of full scale of the maximum operating range used during testing and record the analyzer response. For dry measurements, this mixture may be introduced into the sample system prior to the water trap. The analyzer response must not be more than one percent of full scale for ranges equal to or above 300 ppm or more than three ppm for ranges below 300 ppm.

(c) NO_X analyzer quench check. The two gases of concern for CLD (and HCLD) analyzers are CO_2 and water vapor. Quench responses to these two gases are proportional to their concentrations and, therefore, require test techniques to determine quench at the highest expected concentrations experienced during testing.

(1) NO_X analyzer CO_2 quench check. (i) Pass a CO_2 span gas having a concentration of 80 percent to 100 percent of full scale of the maximum operating range used during testing through the CO_2 NDIR analyzer and record the value as ''a.''

(ii) Dilute the CO_2 span gas approximately 50 percent with NO span gas and pass through the CO_2 NDIR and CLD (or HCLD). Record the CO_2 and NO values as ''b'' and ''c'', respectively.

(iii) Shut off the CO_2 and pass only the NO span gas through the CLD (or HCLD). Record the NO value recorded as ''d.''

(iv) Calculate the percent CO_2 quench as follows, which may not exceed three percent:

percent CO_2 quench = $100 - 100 \times [c \times a/(d \times a - d \times b)] \times a/b$

Where:

a=Undiluted CO_2 concentration (percent)
b=Diluted CO_2 concentration (percent)
c=Diluted NO concentration (ppm)
d=Undiluted NO concentration (ppm)

(2) NO_X analyzer water quench check. (i) This check applies to wet measurements only. Pass an NO span gas having a concentration of 80 percent to 100 percent of full scale of a normal operating range through the CLD (or HCLD). Record the response as ''D.'' Bubble through water at room temperature the NO span gas and pass it through the CLD (or HCLD). Record the analyzers response as ''AR.'' Determine and record the analyzers absolute operating pressure and the bubbler water temperature. (It is important that the NO span gas contains minimal NO_2 concentration for this check. No allowance for absorption of NO_2 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 ''Pwb'') that corresponds to the bubbler water temperature. Calculate the water concentration (''Z1'', percent) in the mixture by the following equation:

Z1 = $100 \times (Pwb / GP)$

Where: