APPENDIX E TO PART 52—PERFORMANCE
SPECIFICATIONS AND, SPECIFICATION
TEST PROCEDURES FOR MONITORING
SYSTEMS FOR EFFLUENT STREAM
GAS VOLUMETRIC FLOW RATE

1. *Principle and applicability.*

1.1 *Principle.* Effluent stream gas volumetric flow rates are sampled and analyzed by a continuous measurement system. To verify the measurement system performance, values obtained from the measurement system are compared against simultaneous values obtained using the reference method. These comparison tests will be performed to determine the relative accuracy, and drift of the measurement system over the range of operating conditions expected to occur during normal operation of the source. If the measurement system is such that the specified tests in section 5.1 for drift do not apply, those test procedures shall be disregarded.

1.2 *Applicability.* This method is applicable to subparts which require continuous gas volumetric flow rate measurement. Specifications are given in terms of performance. Test procedures are given for determining compliance with performance specifications.

2. *Apparatus.*

2.1 Continuous measurement system for determining stack gas volumetric flow rate.

2.2 Equipment for measurement of stack gas volumetric flow rate as specified in the reference method.

3. *Definitions.*

3.1 *Measurement system.* The total equipment required for the determination of the gas volumetric flow rate in a duct or stack. The system consists of three major subsystems:

3.1.1 *Sampling interface.* That portion of the measurement system that performs one or more of the following operations: Delineation, acquisition, transportation, and conditioning of a signal from the stack gas and protection of the analyzer from any hostile aspects of the source environment.

3.1.2 *Analyzer.* That portion of the measurement system which senses the stack gas flow rate or velocity pressure and generates a signal output that is a function of the flow rate or velocity of the gases.

3.1.3 *Data presentation.* That portion of the measurement system that provides a display of the output signal in terms of volumetric flow rate units, or other units which are convertible to volumetric flow rate units.

3.2 *Span.* The value of gas volumetric flow rate at which the measurement system is set to produce the maximum data display output. For the purposes of this method, the span shall be set at 1.5 times the maximum volumetric flow rate expected under varying operating conditions of the source.

3.3 *Zero drift.* The change in measurement system output over a stated period of time of normal continuous operation when gas volumetric flow rate at the time of the measurements is zero.

3.4 *Calibration drift.* The change in measurement system output over a stated time period of normal continuous operation when the gas volumetric flow rate at the time of the measurement is 67 percent of the span value.

3.5 *Operation period.* A minimum period of time over which a measurement system is expected to operate within certain performance specifications without unscheduled maintenance, repair, or adjustment.

3.6 *Orientation sensitivity.* The angular tolerance to which the sensor can be misaligned from its correct orientation to measure the flow rate vector before a specified error occurs in the indicated flow rate compared to the reference flow rate.

3.7 *Reference method.* Method 2 as delineated in 40 CFR Part 60.

4. *Measurement system performance specifications.* A measurement system must meet the performance specifications in Table E–1 to be considered acceptable under this method.

TABLE E–1

Parameter	Specifications
Accuracy (relative)	<10 percent of mean reference value (paragraph 6.3.1).
Zero drift (24 hours)	<3 percent of span (paragraph 6.3.2).
Calibration drift (24 hours)	<3 percent of span (paragraph 6.3.3).
Operational period	<168 hours minimum.

5. *Test procedures.*

5.1 Field test for accuracy, zero drift, calibration drift, and operation period.

5.1.1 *System conditioning.* Set up and operate the measurement system in accordance with the manufacturer's written instructions and drawings. Offset the zero point of the chart recorder so that negative values up to 5 percent of the span value may be registered. Operate the system for an initial 168-hour conditioning period. During this initial period, the system should measure the gas stream volumetric flow rate in a normal operational manner. After completion of this conditioning period, the formal 168-hour performance and operational test period shall begin.

5.1.2 *Field test for accuracy and operational period*. During the 168-hour test period, the system should be continuously measuring gas volumetric flow rate at all times. During this period make a series of 14 volumetric flow rate determinations simultaneously using the reference method and the measurement system. The 14 determinations can be made at any time interval at least one hour apart during the 168-hour period except that at least one determination on five different days must be made with one determination on the last day of such period. The determinations shall be conducted over the range of volumetric flow rates expected to occur during normal operation of the source. The measurement system volumetric flow rate reading corresponding to the period of time during which each reference method run was made may be obtained by continuous integration of the measurement system signal over the test interval. Integration may be by use of mechanical integration of electrical units on the chart recorder or use of a planimeter on the strip chart recorder. The location and orientation of the reference method measurement device and the measurement system should be as close as practical without interference, but no closer than 1.3 cm (0.5 inch) to each other and shall be such that dilution air or other interferences cannot be interjected into the stack or duct between the pitot tube and the measurement system. Be careful not to locate the reference method pitot tube directly up or down stream of the measurement system sensor.

5.1.3 *Field test for calibration drift and zero drift*. At 24-hour intervals, but more frequently if recommended by the manufacturer, subject the measurement system to the manufacturer's specified zero and calibration procedures, if appropriate. Record the measurement system output readings before and after adjustment. Automatic corrections made by the system without operator intervention are allowable at anytime.

5.1.4 *Field test for orientation sensitivity*. If a velocity measurement system is either a single point measurement device or a pressure sensor or any other device such as pitot tube which uses the flow direction of the test gas, then the following test shall be followed and a performance specification of ±10 degrees device orientation sensitivity for ±4 percent flow rate determination accuracy must be met in order for the measurement system to be considered acceptable under this method. This is in addition to the performance specifications given in paragraph 4 of this appendix. During a period of relatively steady state gas flow, perform the following orientation test using the measurement system. The system should be continuously measuring gas velocity at all times. Rotate the measurement 10° on each side of the direction of flow in increments of 5°. Perform this test three times each at:

(1) Maximum operating velocity (±15 percent);

(2) 67 percent ±7.5 percent of the maximum operating velocity; and

(3) 33 percent ±7.5 percent of the maximum operating velocity if (2) and (3) are normal operating practices.

6. *Calculations data analysis and reporting*.

6.1 *Procedure for determination of stack gas volumetric flow rate*. Calculate the reference stack gas velocity and corresponding stack gas volumetric flow rate with the calibrated type S pitot tube measurements by the reference method. Calculate the measurement system stack gas volumetric flow rate as specified by the manufacturer's written instructions. Record the volumetric flow rates for each in the appropriate tables.

6.2 *Procedure for determination of mean values and 95 percent confidence intervals*.

6.2.1 *Mean value*. The mean value of a data set is calculated according to Equation E–1.

EQUATION E–1

$$\overline{\chi} = \frac{1}{n}\sum_{i=1} \chi_i$$

Where:

x_i=individual values.
Σ=sum of the individual values.
x=mean value.
n=data points.

6.2.2 *95 percent confidence level*. The 95 percent confidence level (two sided) is calculated according to Equation E–2.

EQUATION E–2

$$C.I._{.95} = \frac{t_{.975}}{n\sqrt{n-1}}\sqrt{n\left(\sum \chi_i 2\right) - \left(\sum \chi_i\right)^2}$$

Where:

Σx_i=sum of all data points.
(Σx_i)=sum of squares of all data points.
$C.I._{.95}$=95 percent confidence interval estimate of the average mean value.

VALUES FOR *t*.975

n	t.975	n	t.975	n	t.975
2	12.706	7	2.447	12	2.201
3	4.303	8	2.365	13	2.179
4	3.182	9	2.306	14	2.160
5	2.776	10	2.262	15	2.145
6	2.571	11	2.228	16	2.131

The values in this table are already corrected for *n*–1 degrees of freedom. Use *n* equal to the number of samples as data points.

6.3 *Data analysis and reporting*.

6.3.1 *Accuracy (relative)*. First, calculate the mean reference value (Equation E–1) of

the 14 average volumetric flow rates calculated by the reference method. Second, from the 14 pairs of average volumetric flow rates calculated by the reference method and measurement system volumetric flow rate readings, calculate the mean value (Equation E–1) of the differences of the 14 paired readings. Calculate the 95 percent confidence interval (Equation E–2) using the differences of fourteen paired readings. To calculate the values in the second part of this section substitute d_i for x_i and d for x in Equations E–1 and E–2 where d_i equals the difference of each paired reading and d equals the mean value of the fourteen paired differences. Third, report the sum of the absolute mean value of the differences of the fourteen paired readings and the 95 percent confidence interval of the differences of value calculated in the first part of the section. Divide this total by the mean reference value and report the result as a percentage. This percentage is the relative accuracy.

6.3.2 *Zero drift* (*24 hour*). From the zero values measured each 24 hours during the field test, calculate the differences between successive readings expressed in volumetric flow rate units. Calculate the mean value of these differences and the confidence interval of these differences using Equations E–1 and E–2. Report the sum of the absolute value of the mean difference and the confidence interval as a percentage of the measurement system span. This percentage is the zero drift.

6.3.3 *Calibration drift* (*24 hour*). From the calibration values measured every 24 hours during the field test calculate the differences between: (1) The calibration reading after zero and calibration adjustment, and (2) the calibration reading 24 hours later after zero adjustment but before calibration adjustment. Calculate the mean value of these differences and the confidence interval using

Equations E–1 and E–2. Report the sum of the absolute value of the mean difference and confidence interval as a percentage of the measurement system span. This percentage is the calibration drift.

6.3.4 *Operation period*. Other than that clearly specified as required in the operation and maintenance manual, the measurement system shall not require any corrective maintenance, repair, replacement or adjustment during the 168-hour performance and operational test period. If the measurement system operates within the specified performance parameters and does not require corrective maintenance, repair, replacement or adjustment other than as specified above during the 168-hour test period, the operational period will be successfully concluded. Failure of the measurement to meet this requirement shall call for a repetition of the 168-hour test period. Portions of the test, except for the 168-hour field test period, which were satisfactorily completed need not be repeated. Failure to meet any performance specifications shall call for a repetition of the one-week performance test period and that portion of the testing which is related to the failed specification. All maintenance and adjustments required shall be recorded. Output readings shall be recorded before and after all adjustments.

6.3.5 *Orientation sensitivity*. In the event the conditions of paragraph 5.1.4 of this appendix are required, the following calculations shall be performed. Calculate the ratio of each measurement system reading divided by the reference pitot tube readings. Graph the ratio vs. angle of deflection on each side of center. Report the points at which the ratio differs by more than ±4 percent from unity (1.00).

[40 FR 5521, Feb. 6, 1975]

APPENDIX F TO PART 52—CLEAN AIR ACT SECTION 126 PETITIONS FROM EIGHT NORTHEASTERN STATES: NAMED SOURCE CATEGORIES AND GEOGRAPHIC COVERAGE

The table and figures in this appendix are cross-referenced in §52.34.

TABLE F–1—NAMED SOURCE CATEGORIES IN SECTION 126 PETITIONS

Petitioning state	Named source categories
Connecticut	Fossil fuel-fired boilers or other indirect heat exchangers with a maximum gross heat input rate of 250 mmBtu/hr or greater and electric utility generating facilities with a rated output of 15 MW or greater.
Maine	Electric utilities and steam-generating units with a heat input capacity of 250 mmBtu/hr or greater.
Massachusetts	Electricity generating plants.
New Hampshire	Fossil fuel-fired indirect heat exchange combustion units and fossil fuel-fired electric generating facilities which emit ten tons of NO_X or more per day.
New York	Fossil fuel-fired boilers or indirect heat exchangers with a maximum heat input rate of 250 mmBtu/hr or greater and electric utility generating facilities with a rated output of 15 MW or greater.
Pennsylvania	Fossil fuel-fired indirect heat exchange combustion units with a maximum rated heat input capacity of 250 mmBtu/hr or greater, and fossil fuel-fired electric generating facilities rated at 15 MW or greater.
Rhode Island	Electricity generating plants.