Chapter 2
Implementing Rules - Requirements for Installation of CEM Systems

A discussion of various regulations is presented in this chapter to help the user evaluate non-criteria pollutant monitoring programs in the context of established regulatory concepts. A review of current requirements, emphasizing those where non-criteria pollutant monitoring is required, is also presented. Monitoring regulations now being developed are discussed briefly.

The information contained in this chapter is intended for those that are new to the field of continuous monitoring. Understanding the evolution of existing monitoring requirements and the interrelationship of different regulatory programs is especially important in the development of new monitoring programs. The following sections illustrate a range of monitoring approaches, quality assurance requirements, and regulatory uses of continuous monitoring data. This background information will be helpful in establishing and negotiating monitoring requirements for non-criteria pollutant monitoring programs.

2.1 Clean Air Act, RCRA, and Other Federal Monitoring Requirements

Federal pollutant monitoring requirements for air emissions are contained in regulations developed under several different statutes. Most notably, monitoring requirements are included in several different regulatory programs developed over the last twenty-five years under the Clean Air Act (CAA). These have included new source performance standards, national emission standards for hazardous pollutants, and the acid rain program. Also under the Clean Air Act authority, the EPA has established federal requirements for states to adopt and implement pollutant monitoring programs in State Implementation Plans designed to achieve conformance with ambient air quality standards. These requirements are contained in Part 51.

Air pollutant emissions from sources that burn hazardous waste are regulated under federal regulations derived from the Resource Conservation and Recovery Act (RCRA). Proposed revisions to the hazardous waste combustor regulations combine the CAA air program requirements and RCRA requirements into a single set of regulations for these sources. Air pollutant emissions from sewage sludge incinerators are regulated under Section 503 of the Clean Water Act. Emissions of radioactive materials are not described here.

2.1.1 NSPS Requirements

EPA regulations contained in 40 CFR 60, "Standards of Performance for New Stationary Sources," (commonly referred to as NSPS) apply to selected categories of stationary sources of air pollution for which EPA has developed specific regulations to limit emissions of criteria pollutants and certain designated pollutants. Over the past 25 years, the EPA has developed NSPS regulations for more than 68 source categories. In most cases, these regulations only apply to sources above specific size thresholds and for which construction began after the date of the proposed regulation. NSPS regulations limit emissions of criteria air pollutants including particulate, SO_2, NO_x, and CO. Emissions of volatile organic compounds (VOCs) also are limited because of their role in photochemical reactions resulting in the formation of ozone in the ambient air. Other non-criteria pollutants that are regulated directly or indirectly under NSPS include total reduced sulfur compounds (TRS), hydrogen sulfide (H_2S), and hydrogen chloride (HCl).

NSPS regulations are designed to require the installation and proper operation of "best demonstrated control" better known as "Best Available Control Technology" (BACT) to minimize emissions of pollutants. In general, a performance-based approach has been adopted whereby an affected facility can choose any method of pollutant reduction provided that the source operator can demonstrate compliance with the applicable emission limits by conducting performance tests. In most cases, specific test methods or monitoring requirements for conducting the demonstration of compliance are detailed within the applicable NSPS regulations. Where possible, the same methods that were used during the standard setting process to determine the level of pollutant emissions corresponding to BACT are also used to demonstrate

compliance. In this way, the uncertainty (bias and imprecision) of the measurement method and the averaging period of the applicable standard are taken into account. Because of this approach, the exact test methods and monitoring procedures used for compliance demonstrations are of great importance. Test methods are found in Appendix A and Performance Specifications for continuous emission monitors are included in Appendix B of 40 CFR 60.

Many sources subject to NSPS particulate emission standards are also subject to an opacity standard. For the most part, compliance with the opacity standard is determined by a trained human observer in accordance with EPA Method 9. Continuous monitoring of opacity of emissions is required for certain sources. NSPS regulations adopted since the 1977 Clean Air Act Amendments have prescribed "percent removal" requirements in addition to emission limitations for certain sources. In some cases, continuous emissions monitoring is required to demonstrate compliance with percent removal requirements.

2.1.1.1 "Proper O&M Monitoring" versus "Compliance Monitoring"

Initial NSPS regulations required the use of specific manual test methods for demonstrating compliance with particulate, SO_2, and NO_x emission limits. Method 9, Visible Emission Observations, was specified for determining compliance with opacity standards. CEM requirements for large boilers (heat input $\geq$ 250 million BTU/hr), sulfuric and nitric acid plants, and non-ferrous smelters were included in NSPS regulations promulgated in December of 1971. The data provided by these monitors could not be used to determine compliance with emission limits but were used instead to determine if a source was "properly operating and maintaining process and control equipment in a manner consistent with good air pollution control practices" as is required by 60.11(d). This regulatory application of continuous monitors has become known as "proper O&M monitoring." Monitoring results have been used to enforce the requirement of 60.11(d). These monitoring results have also been used as a trigger for other activities such as agency source inspections, visible emission observations, or requiring additional compliance demonstration tests. The EPA expanded this regulatory application of a CEM system to other source categories in subsequent regulations. Today, opacity CEM systems are by far the most widely used monitoring technique at NSPS sources. They remain as tools for enforcement of the general 60.11(d) proper O&M monitoring requirement rather than for direct determination of compliance with applicable opacity standards.

Subsequent to the 1977 CAAA, NSPS Subpart Da was proposed and later promulgated after litigation. Subpart Da applies to large electric utility steam generators constructed after Sept. 1978. It requires the use of a CEM system for the continuous demonstration of compliance with SO_2 and NO_x emission standards and SO_2 percent removal requirements. Compliance with these requirements is determined on a thirty-day rolling average basis. Subpart Da requirements include explicit minimum data availability requirements and also impose additional quality assurance requirements for SO_2 and NO_x CEM systems contained in Appendix F, Procedure 1 of Part 60. Since the promulgation of Subpart Da, continuous compliance monitoring applications of SO_2 and NO_x CEM systems have been promulgated for other large boilers, municipal waste combustors, and several other source categories.

2.1.1.2 Summary of NSPS Criteria Pollutant Monitoring Requirements

A summary of the NSPS criteria pollutant continuous emission monitoring requirements is presented in Table 2-1. Diluent (O_2 or CO_2) monitoring that is required to convert pollutant concentrations to units of the applicable standard is also indicated for different source categories. The compliance averag-ing period for CEM data is shown for those source categories and pollutants where monitoring data are used to demonstrate compliance with emission standards. The time period for determining and reporting excess emissions is shown for other moni-toring applications. The reader is cautioned that exemptions and exceptions affecting many sources are detailed within the regulations for some source categories. The actual Part 60 regulations should be consulted for additional information, specific exemp-tions, averaging periods, reporting requirements, and other information.

2.1.1.3 Summary of NSPS Non-criteria Pollutant Monitoring Requirements

A summary of the NSPS non-criteria pollutant monitoring requirements is presented in Table 2-2. Existing non-criteria pollutant monitoring requirements address emissions of volatile organic compounds (VOCs), total reduced sulfur compounds (TRS), and hydrogen sulfide (H_2S) monitoring in petroleum refinery fuel gas. All of the NSPS non-criteria pollutant monitoring applications are used to ensure proper operation and maintenance of source process and control equipment. Emissions exceeding specific levels are reported as

Table 2-1. NSPS Criteria Pollutant Monitoring Requirements

Subpart - Effective Date	Source Category and Type	Pollutant and Diluent Monitors	Compliance Averaging Period For CEMS DATA	Excess Emissions Reporting Period
D - 8/17/71	Fossil Fuel-Fired Steam Generators > 250 x 10^6 Btu/hour heat input	SO_2 and NO_x (O_2 or CO_2 as diluent)		3 hours
		Opacity		6 minutes
Da - 9/18/78	Electric Utility Steam Generating Units > 73 MW (250 x 10^6 Btu/hour) heat input	SO_2 and NO_x emissions, SO_2 percent removal (O_2 or CO_2 as diluent)	30-day rolling average (boiler operating days)	
		Opacity		6 minutes
Db - 11/25/86 NO_x 6/19/84	Industrial-Commercial-Institutional Steam Generators >29 MW (100 x 10^6 Btu/hour) heat input	SO_2 and NO_x emissions, SO_2 percent removal (O_2 or CO_2 as diluent)	30-day rolling average (boiler operating days)	
		Opacity		6 minutes
Dc - 6/9/89	Small Industrial-Commercial-Institutional Steam Generators >2.9 MW < 29 MW (10 to 100 x 10^6 Btu/hour) heat input	SO_2 emissions, SO_2 percent removal (certain sources) (O_2 or CO_2 as diluent)	30-day rolling average (boiler operating days)	
		Opacity		6 minutes
Ea - 12/20/89	Municipal Waste Combustors >250 tons/day	SO_2 with O_2 as diluent, SO_2 percent removal (certain sources)	24 hours	
		NO_x emissions with O_2 as diluent	24 hours	
		CO with O_2 as diluent	4 hour and 24 hour periods	
		Opacity		6 minutes
F - 8/17/71	Portland Cement Plants	Opacity		6 minutes
G - 8/17/71	Nitric Acid Plants	NO_x emissions		3 hours
H - 8/17/71	Sulfuric Acid Plants	SO_2 emissions (O_2 or CO_2 monitors or other procedures to calculate emissions)		3 hours
J - 6/11/73	Petroleum Refineries			
	Fluid Catalytic Cracking Unit Regenerators	CO		1-hour
		SO_2 emissions SO_2 removal, sulfur oxides (certain sources)	7-day rolling average	
		Opacity		6 minutes
J - 6/11/73	Fuel Gas Combustion Devices	SO_2 with O_2 as diluent, (H_2S in fuel gas as alternative)		3-hour rolling average

Table 2-1. Continued.

Subpart - Effective Date	Source Category and Type	Pollutant and Diluent Monitors	Compliance Averaging Period For CEMS DATA	Excess Emissions Reporting Period
J - 10/4/76	Claus Sulfur recovery Plant > 20 LTD* with oxidation control system	SO_2 with O_2 as diluent		12 hours
J - 10/4/76	Claus Sulfur recovery Plant > 20 LTD with reduction control system	TRS with O_2 as diluent or dilution sampling system with oxidation and SO_2 with O_2 as diluent		12 hours
P - 10/16/74	Primary Copper Smelter			
	Dryer	Opacity		6 minutes
	Roaster, smelting furnace, and copper converter	SO_2	6-hour period	
R - 10/16/74	Primary Lead Smelter			
	Blast furnace, dross reverberatory furnace, or sintering machine discharge	Opacity		6 minutes
	Sintering machine, electric smelting furnace, and converter	SO_2	2-hour period	
Z - 10/21/74	Ferroalloy Product Facilities, submerged electric arc furnaces	Opacity		6 minutes
AA - 10/21/74 to 8/17/83	Steel Plants-Electric Arc Furnaces and Argon Decarburization Vessels (exceptions for certain controls)	Opacity		6 minutes
Aaa - 8/17/83	Steel Plants - Electric Arc Furnaces and Argon Decarburization vessels (exceptions for certain controls)	Opacity		6 minutes
BB - 9/24/76	Kraft Pulp Mills			
	Recovery Furnaces	Opacity		6 minutes
CC - 6/15/79	Glass Manufacturing Plants	Opacity		6 minutes
HH - 5/3/77	Lime Manufacturing Plants, rotary lime kilns	Opacity		6 minutes
NN - 9/21/79	Phosphate Rock Plants, dryers, calciners, and grinders	Opacity		6 minutes
LLL - 1/20/84	Onshore Natural Gas Processing, sweetening units	Velocity (also SO_2 if oxidation control system or reduction control system followed by incinerator is used)		24 hours
UUU - 4/23/86	Calciners and Dryers in Mineral Industries (with dry control devices)	Opacity		6 minutes

*LTD = Long Tons per Day

Table 2-2. NSPS Non-criteria Pollutant Monitoring Requirements

Subpart - Effective Date	Source Category and Type	Pollutant and Diluent Monitors	Excess Emissions Reporting Period
J	Petroleum Refineries		
J - 6/11/73	Fuel Gas Combustion Devices	H_2S in fuel gas (as alternative to SO_2 with O_2 in emissions)	3-hour rolling average
J - 10/4/76	Claus Sulfur recovery Plant > 20 LTD with reduction control system	TRS with O_2 as diluent or dilution sampling system with oxidation and SO_2 with O_2 as diluent	12 hours
BB - 9/24/76	Kraft Pulp Mills - Emissions from recovery boilers, lime kilns, digester system, brown stock washer system, evaporator, and condensate stripper systems	TRS with O_2 as diluent	12 hours
DDD - 9/30/87	VOC Emissions from Polymer Industry		
	Carbon absorbers	VOC	3 hours
	Condensers	Temperature or VOC	3 hours
FFF - 1/18/83	Flexible Vinyl and Urethane Coating and Printing - Rotogravure printing lines with recovery units	VOC	3 hours
III - 10/21/83	Synthetic Organic Chemical Manufacturing Industry - Units with air oxidation reactors	Specified parameters or VOC CEMS	3 hours
LLL - 1/20/84	Onshore Natural Gas Processing, sweetening units	velocity, (TRS and/or SO_2 as alternative for certain sources)	24 hours
QQQ - 5/4/87	Petroleum Refinery Waste Water System - Units with carbon absorbers	VOC	3 hours
SSS - 1/22/86	Magnetic Tape Coating Facilities - Units with carbon absorbers	VOC inlet and outlet streams for certain sources	3 hours
VVV - 4/30/87	Polymeric Coating of Supporting Substrates - Units with carbon absorbers	VOC inlet and outlet streams for certain sources	3 hours

"excess emissions." The monitoring results from these applications are not used to determine compliance with emission standards. Other designated pollutants such as HCl are regulated in Part 60 because of potential welfare impacts resulting from emissions. During the development of the Subpart Ea for municipal waste combustors, the EPA considered including an HCl continuous emission monitoring requirement. However, the final rule relies on annual HCl emissions tests in conjunction with the continuous demonstration of SO_2 removal efficiency to control HCl emissions. In this case, the continuous monitoring of SO_2 emission levels up-stream and downstream of the acid gas control device serves as a surrogate for the direct monitoring of HCl emissions.

2.1.1.4 NSPS Parameter Monitoring Requirements

Many parameter monitoring requirements are included in NSPS regulations with measurement frequencies ranging from monthly to continuous. Selected NSPS parameter monitoring requirements are presented in Table 2-3. Similar requirements are contained in the applicable regulations for many other source categories. These and other NSPS parameter monitoring requirements are necessary for a variety of purposes.

Table 2-3. Example NSPS Parameter Monitoring Requirements

Subpart	Source Category and Type	Parameter	Measurement Frequency	Accuracy
O	Sewage Treatment Plants	feed rate	continuously	±5%
		fuel flow rate to incinerator	continuously	±5%
E,F,G,S	Incinerators, Portland Cement Plants, Nitric Acid Plants, Primary Aluminum Reduction Plants	feed rate or production rate	daily	±2%
GG	Stationary Gas Turbines	natural gas flow rate	continuously	±5%
		water to fuel ratio	continuously	±5%
DDD,III,NNN	VOC Emissions from; Polymer Manufacturing Industry, SOCMI Air Oxidation Unit Processes, and SOCMI Distillation Operations	absorber scrubber liquid temperature and specific gravity	continuously	±1% or ±0.5°C and ±0.02 s.g
		boiler or process heater combustion temperature	continuously or every 15 minutes	±1% or ±0.5°C
		flare (on/off)	continuously	
		incinerator combustion temperature	continuously	±1% or ±0.5°C
N,O,Y,HH, LL and many others	Secondary Emissions from Basic Oxygen Steelmaking Facilities, Sewage Treatment Plants, Coal Preparation Plants, Lime Manufacturing Plants, Metallic Mineral Processing Plants	wet scrubber pressure drop	continuously	±1 inch H_2O

Parameter monitoring may be required where pollutant monitoring is impractical or infeasible. For example, NSPS regulations provide an exemption from continuous opacity monitoring requirements if condensed water (droplets) exist at the monitoring location and interfere with the measurement. Monitoring certain parameters is required for determining process or production rates in conjunction with pollutant monitoring data to determine emissions in units of the standard. For example, sulfuric and nitric acid plants monitor certain process parameters to calculate the mass of SO_2 or NO_x emitted per ton of acid produced. Steam generators that combust varying fuel mixtures must monitor the heat input rate (fuel usage) for each fuel to select appropriate F-factors and properly calculate emissions in units of mass of pollutant per unit of heat input. Other sources are required to monitor production rate or operating hours to demonstrate that they are exempt from a particular monitoring requirement.

A number of "demonstrated compliance parameter level" approaches occur within NSPS regulations. In these applications, a specific parameter level is prescribed within the regulation or determined by empirical tests that will ensure compliance with the emission limitation. Thus, the parameter value becomes a surrogate for the emission limit. For example, the outlet temperature for catalytic VOC incinerators must be monitored and maintained above a minimum to ensure that VOCs are combusted properly. As another example, the water injection rates necessary to achieve compliance with NO_x emission limits for an NSPS Subpart GG gas turbine are demonstrated at each of four operating loads during the initial compliance test. Subsequently, the operating load and water injection rate are monitored continuously to ensure compliance with NO_x emission limitations.

Other NSPS parameter monitoring requirements are quite diverse. They include monitoring of sulfur content of coal to calculate SO_2 emissions for certain sources where SO_2 monitoring is not required and for other sources where fuel sulfur pretreatment credits are applied towards SO_2 removal requirements. Certain source categories involved in coating operations must monitor the VOC content of coatings to demonstrate compliance with applicable limits. Other sources must monitor compliance with various "work practice standards" ranging from simply covering solvent containers or closing ventilation hood inspection doors, to wetting of unpaved roads to reduce fugitive particulate

emissions at stone and mineral processing facilities. These types of requirements are specific to particular source categories. They are established during the rule making process in consideration of many factors including technology limitations and cost.

2.1.1.5 NSPS Monitoring Regulations and Performance Specifications

Important aspects of NSPS CEM programs are prescribed in several sections of 40 CFR 60. Requirements applicable to all sources are found in "Subpart A. General Provisions." Of these, "§60.13 Monitoring Requirements" includes requirements for source operators to conduct daily zero and upscale calibration checks, to perform an initial test of each CEM system in accordance with applicable Appendix B Performance Specifications, and other essential elements of a monitoring program. Other requirements applicable to continuous monitoring programs are found in §60.7 Notification and Recordkeeping, and §60.11 Compliance with Standards and Maintenance Requirements.

Generally, each source category subpart with a continuous monitoring requirement includes (or references) additional specific monitoring requirements and information. This typically includes requirements for the selection of the monitor span value, identification of Appendix A test methods that may be used to conduct relative accuracy tests, methods for converting emissions to units of the standard, and other technical requirements. For proper O&M monitoring applications, reporting requirements and specifications used to identify periods of excess emissions are included. For compliance monitoring applications, emissions averaging periods and detailed compliance reporting requirements are included.

Appendix B of Part 60 includes CEM performance specifications for a number of different compounds and applications. These are listed in Table 2-4. These specifications and procedures are used to determine whether a particular CEM system is acceptable at the time of, or soon after, installation at a particular source. The performance specifications are the minimum procedures that are required to determine if a CEM system is capable of providing reliable measurements. They are not sufficient to assure the quality of the data obtained on an ongoing basis. The first three specifications were originally promulgated in October 1975 and have been revised substantially several times.

Performance Specification 1 (PS 1) applies to opacity monitors and includes a detailed list of <u>design specifications</u> to prescribe how the optical transmission measurement is to be made. In addition, <u>performance specifications</u> are included in PS 1 to determine 1) the stability of the monitor response relative to its simulated zero and upscale calibration checks, 2) the monitor's calibration error relative to a set of external optical density filters, and 3) the instrument's capability to operate for a period of two weeks without unscheduled maintenance or repairs. PS 1 does not include a relative accuracy specification because no independent method is available to measure the in-stack opacity. (Substantial technical and administrative revisions to PS 1 were proposed on November 25, 1994 (59 FR 60585). EPA's and industry's consideration of these revisions is ongoing at the time of this writing.)

All other performance specifications reflect a different approach than PS 1. No substantial design requirements are included. In essence, any sampling system configuration and/or any analytical approach may be used provided that the measurement system can be shown to meet two basic performance specifications. First, a drift test is conducted over a one-week period to evaluate the stability of the monitor response relative to the calibration materials and the procedure used for the daily zero and upscale calibration checks. Second, a relative accuracy test is performed that involves the comparison of the CEM system measurement results with concurrent independent pollutant measurements obtained through the use of specified test methods found in Appendix A of Part 60. The relative accuracy test includes a minimum of nine runs although twelve are more common since the tester is free to reject up to three runs on an arbitrary basis. The computation of the relative accuracy test result includes both mean difference and confidence coefficient terms based on the paired CEM system and reference test results. Thus, both the accuracy and precision of the paired measurements are evaluated. Failure of a relative accuracy test may be due to problems with the CEM system, problems with the reference test methods, problems with the representativeness of the sampling location, or other factors. A failed test requires careful investigation to determine the cause and then it must be repeated. A successful relative accuracy test is considered to be an adequate demonstration of the monitor's <u>capability</u> to provide reliable data.

Table 2-4. NSPS Appendix B Performance Specifications

Performance Specifications	CEM Systems
PS 1	Opacity
PS 2	SO_2 and NO_x
PS 3	O_2 and CO_2
PS 4	CO
PS 4A	CO (applicable for municipal waste combustors)
PS 5	TRS
PS 6	Continuous Flow
PS 7	H_2S (H_2S in fuel gas)
PS 8	VOC
PS 9	Gas Chromatography

Performance Specifications 2 (SO_2 and NO_x) and 3 (O_2 and CO_2) were promulgated originally in October of 1975 and included relative accuracy, calibration error, response time, 2- and 24-hour zero and calibration drift specifications, and continuous operational requirements for two separate one-week periods. Numerous corrections and more detailed technical test procedures were proposed as revisions to PS 2 and 3 during 1983 in response to severe industry criticism of the existing performance specifications. (This criticism arose as a result of the proposal, and subsequent promulgation, of Subpart Da which included the first use of a CEM system for compliance monitoring.) The 1983 proposed revisions to PS 2 were met with more objections from the utility industry. The EPA subsequently reproposed and then promulgated revisions to PS 2 which eliminated all of the performance specifications except for relative accuracy and the seven-week drift test. In addition, specific CEM measurement location requirements were reduced with general guidance. These changes reduced the prescriptiveness of the regulations and placed the responsibility on industry for determining the acceptability of monitoring systems. This philosophy has been maintained in revisions to PS 2 and 3 and has been used to develop PS 4 through PS 8. A different approach has been used for PS 9 which eliminates the relative accuracy test and relies solely on the use of a multiple calibration gases to assess the accuracy of the monitoring data.

Appendix F, Procedure 1 of Part 60 prescribes quality assurance requirements for CEM systems that are used to demonstrate compliance with emission limitations or percent removal requirements. They include: 1) requirements to develop quality control procedures for five specific activities, 2) "out-of-control" limits on daily zero and calibration drift check results for determining when data can not be used to satisfy minimum data requirements, and 3) quarterly accuracy assessment procedures and "out-of-control" criteria for such audits. Procedure 1 requires that a relative accuracy audit be performed each year as one of the quarterly accuracy audits. Three-run relative accuracy audits or cylinder gas audits may be performed for the other three quarters.

2.1.2 Acid Rain Program

EPA has developed the Acid Rain Program in re-sponse to the 1990 Clean Air Act Amendments. The program seeks to reduce SO_2 emissions from the electric utility industry by 10 million tons per year (relative to 1985 emissions) by the year 2010 utilizing a market-based trading approach. Under this program, each electric utility generating unit received the right to emit a certain quantity of SO_2 each year. This right is expressed as a number of "allowances" to emit one ton of SO_2. An allowance trading program has been established to provide for the sale or exchange of SO_2 allowances between electric utility units, companies, or other parties. Market forces within the utility industry are expec-ted to determine the most effective means of achieving the overall SO_2 emission reduction. Addi-tional

regulations are being developed to limit emissions of NO_x from the utility industry as part of the Acid Rain Program.

Extensive continuous emission monitoring programs serve as the basis for the allowance trading program. These monitoring regulations are contained in 40 CFR 75 and require continuous monitoring of SO_2 and stack gas flow rate to determine the mass emission rate of SO_2 (i.e., lb. SO_2 per hour, tons SO_2 per year). Monitoring of NO_x and diluent (O_2 or CO_2) concentrations also is required to determine emissions in units of lb. NO_x per million Btu of heat input. (These sources must also report mass emissions of CO_2.) The allowance trading program is based on the premise that all emissions must be accounted for. Thus, great emphasis has been placed on the accuracy of the monitoring data at all operating conditions (rather than only at the emission standard level) in the adoption of Part 75 performance specifications and quality assurance procedures. In addition, special procedures have been developed to account for missing data. Within the data substitution procedures required for missing data, incentives are provided for affected sources to achieve high levels of CEM availability. Other key aspects of the Acid Rain Program are the development of electronic reporting mechanisms and comprehensive efforts to implement the program on a consistent basis in all states and jurisdictions.

Essentially, the largest 263 SO_2 emission sources were identified within the 1990 CAAA as Phase 1 sources. All other affected utility sources (approximately 2,000 units) are designated as Phase 2 units. Phase 1 units were required to have a CEM system installed and certified before November 1994. All Phase 2 units were required to have a CEM system installed and certified by Dec. 31, 1995 with the exception of certain gas-fired units and peaking units. The vast majority of all of the affected units were able to install and certify the required CEM system by the applicable deadlines (EPA, 1995a).

2.1.2.1 Flow Rate Monitoring

Before the development of the Acid Rain program, there was little experience with stack gas flow rate monitors installed as part of emission monitoring systems. The performance and reliability of these devices was a very controversial subject during the development of the Part 75 regulations. However, experience has shown that flow rate monitors are capable of meeting the applicable performance specifications in Appendix A of Part 75 including the relative accuracy tests conducted at three different operating loads (Bensink, 1995). Stack gas flow rate monitors are considered reliable monitoring devices even though differences between the stack gas volumetric flow rate determined by heat rate calculations and by flow rate monitors continue to be the subject of investigation by both the EPA and the utility industry.

2.1.2.2 Part 75 Performance Specifications and QA Requirements

These requirements are similar, though somewhat more restrictive, than the Part 60 requirements. The Part 75 performance specifications require use of calibration gases to check the performance of all gas monitoring systems. The specifications include response time tests and a three-point calibration error test. A bias test is also included that is based on comparison of the mean difference and confidence coefficient terms determined during the relative accuracy test. The regulations require application of a bias adjustment factor to emission values if the CEM data are biased low by an amount greater than the confidence coefficient relative to the reference method data.

Part 75 Appendix B quality assurance requirements are also similar to Part 60 requirements. Accuracy audits are required twice each year except for those units which achieve an “incentive” specification in the relative accuracy test. Units that achieve a relative accuracy of less than 7.5% are allowed to perform a single accuracy audit each year.

2.1.3 NESHAP and Title III - MACT Standards

2.1.3.1 Part 61 Existing NESHAP

National emission standards for hazardous air pollutants (NESHAP) are contained in 40 CFR 61. Prior to 1992, EPA promulgated NESHAP for 22 source categories. These regulations limit emissions of arsenic, asbestos, benzene, beryllium, mercury, vinyl chloride, radon, radionuclides, and HAP fugitive emissions from equipment leaks.

Several of the NESHAP regulations include CEM requirements. Subpart A General Provisions, §61.14 includes general monitoring requirements for sources required to monitor continuously. Opacity monitors are required for sources affected by Subparts N, O, and P regulating inorganic arsenic emissions from glass manufacturing plants, copper smelters, and from arsenic trioxide and metal arsenic production plants, respectively. These regulations refer to Performance Specification 1 in Part 60 for evaluations of opacity CEM systems. In addition, parameter monitoring requirements similar to those contained in Part 60 are included for certain sources.

Subpart F requires installation of vinyl chloride CEM systems at certain emission points in ethylene dichloride, vinyl chloride, and polyvinyl chloride plants. Subpart F, §61.68 includes specific technical requirements for monitoring systems that use gas chromatography and flame ionization detectors for analysis of sequential samples. Daily span checks with a 10 ppm calibration gas are required. Procedures contained in Appendix B, Method 106 are referenced for certification of vinyl chloride cylinder standards and for the preparation of calibration curves. A summary of NESHAP monitoring requirements is included in the "Enhanced Monitoring Reference Document" (EPA, 1993).

2.1.3.2 MACT Standards

Title III, Section 112 of the 1990 CAAA identified a list of 189 hazardous air pollutants (HAPs) and requires EPA to establish new NESHAPs for all major sources of HAPs (Appendix A) in accordance with a prescribed regulatory schedule. Major sources are defined as those that emit more than 10 tons per year of one HAP or more than 25 tons per year of a combination of HAPs. The schedule for promulgation of these new standards for affected source categories was originally published in the July 16, 1992 Federal Register (57 FR 31576). The schedule organized sources into "bins." The two-year bin included 40 source categories for which standards were to be promulgated by November 1992. The four-year bin included 25 percent of the listed source categories and the seven-year bin included 50 percent of the listed source categories. All listed categories are to have standards set no later than November 2000.

These regulations are being developed for inclusion in 40 CFR 63 and specify the maximum achievable control technology (MACT) for each source category. The CAAA require sources to obtain case-by-case MACT determinations if EPA has not promulgated a standard within 18 months of the scheduled date.

The MACT standards will include monitoring provisions that will satisfy the requirements of the Act to ensure that source owners are able to certify as to the compliance status of affected emission units. These monitoring requirements will be at least as rigorous (i.e., direct emissions measurement and monitoring of enforceable operational limits) as requirements outlined under Part 64 or Part 70 periodic monitoring requirements. EPA has developed general provisions that are applicable to all MACT standards. The Part 63 General Provisions were promulgated March 16, 1994 and include performance testing, monitoring, and recordkeeping and reporting procedures for sources subject to MACT standards. A current listing of the MACT standards status is published periodically in the Federal Register by the EPA in accordance with the requirements of the CAA. (See April 17, 1996 notice on the EPA Technology Transfer Network (TTN) bulletin board, telephone no. 919-541-5742). Many of the MACT standards require inspection or monitoring of process or control device parameters on a quarterly, monthly, weekly, or daily basis. These requirements are not addressed in this handbook because of the frequency of the measurements. Few of the MACT standards include continuous monitoring requirements.

2.1.3.2.1 HON Rule - Example MACT Standard. As an example, the Hazardous Organic NESHAP (known as the "HON rule") covers manufacturing processes in the synthetic organic chemical manufacturing industry (SOCMI) and regulates emissions from about 370 facilities including approximately 111 of the 189 HAPS (EPA, 1994a). Subpart G of the HON rule contains regulations for emission points at SOCMI sources. Continuous monitoring requirements are summarized in Table 2-5.

2.1.3.2.2 Magnetic Tape - Example MACT Standard. Subpart EE of Part 63 applies to the production of magnetic tapes. Monitoring requirements similar to the HON rule apply for sources using combustion devices for control of volatile emissions. Those source using carbon adsorbers are required to install a CEM system for volatile organic hazardous emissions. Depending on the type of facility, either a total hydrocarbon monitor or a gas chromatograph with an appropriate detector can be used. Performance Specifications 8 and 9 in Appendix A of Part 60 are used to evaluate the performance of these types of CEM systems, respectively. Very similar requirements are found in NSPS Subpart SSS except that the requirements are intended for the control of VOCs.

2.1.3.2.3 Secondary Lead Smelters - Example MACT Standard. A final NESHAP (Part 63, Subpart X) for new and existing secondary lead smelters was published on June 23, 1995 (60 FR 32587). These facilities recover lead metal from scrap lead, primarily from used lead-acid automotive batteries and have been identified as significant emitters of lead and arsenic compounds, and 1,3-butadiene.

Table 2-5. HON Rule Example Continuous Monitoring Requirements

Emission Source	Control System	Monitoring	Frequency
Process Vents	thermal incinerator catalytic incinerator boiler or process heater flare scrubber bypass lines	firebox temp. inlet and outlet temp. firebox temp. presence of flame pH of effluent streams vent stream flow	continuous continuous continuous continuous continuous continuous
Storage Vessels	fixed roof external floating roof closed vent and control	visual inspection visual inspection presence of flame or flare	annual when filled continuous

The MACT standard regulates emissions of lead compounds as surrogates for all metal HAPs and total hydrocarbons (THC) as surrogates for all organic HAPs, respectively. Continuous monitoring requirements are included for baghouse operation and THC emissions.

The proposed regulation would have required the installation of a continuous opacity monitor and the development of a site-specific opacity standard to ensure adequate collection of metal HAPs. However, in view of the many comments opposed to this approach for technical and administrative reasons, the EPA modified this regulation. The final rules in §63.548, require a "standard operating procedure" (SOP) for baghouse inspection and maintenance, and a bag leak detection system with an alarm, and a corrective action procedure for responding to alarms. The bag leak detection system: 1) must be capable of detecting particulate matter concentrations at 1.0 mg/m^3, 2) must provide an output of relative or absolute particulate emissions, 3) must include an alarm system that activates upon detection of an increase in particulate emissions, 4) must be installed downstream of any wet acid gas scrubber or on each compartment of a positive pressure bag-house, and 5) must be installed and operated in a manner consistent with <u>any</u> available guidance from the EPA.

The secondary lead THC monitoring requirements apply to emissions from process sources (i.e., blast and reverberatory furnaces). The THC monitor is used to continuously monitor compliance (3-hour average) with the applicable emission limit ranging from 20 to 360 ppm (as propane) depending on the type of furnace used. The THC monitor must comply with the all of the CEM requirements in the Subpart A, General Provisions.

2.1.4 Regulations for Sources Burning Hazardous Waste

2.1.4.1 Existing Regulations for Sources Burning Hazardous Waste

2.1.4.1.1 Hazardous Waste Incinerators. The treatment of hazardous waste is regulated under the Resource Conservation and Recovery Act (RCRA). Hazardous waste is defined in Part 264. Air pollution emissions from hazardous waste incinerators are regulated in Part 265. Facilities subject to these regulations must demonstrate compliance with prescribed destruction and removal efficiencies (DREs) for metals and organic emissions. The DREs are determined during the Part B permit trial burn by comparing the quantity of materials fed into the incinerator with measured emission rates. Trial burns are extensive testing programs typically involving the measurement of emissions of speciated dioxin/furans, volatile organic compounds, non-dioxin/furan semi-volatile organic compounds, particulate, metals, HCl/Cl_2 and other components. Because of the extreme public concern regarding these facilities, source-specific trial burn plans are developed and negotiated with federal, state, and local agency representatives. Trial burn test results are subject to control agency and public review and are the basis for many of the requirements included in the incinerator operating permit. CEM requirements for CO and THC as well as incinerator and control device operation also are included in hazardous waste incinerator operating permits.

2.1.4.1.2 BIF Regulations. On February 21, 1991 (56 FR 7134), the EPA published a final rule controlling hazardous waste burning by boilers and industrial furnaces (known as the BIF Rule). Currently, the BIF Rule regulates emissions of HCl/Cl_2, CO, particulate matter, metals and organics in essentially the same manner as RCRA hazardous waste incinerators. BIF sources also are regulated under RCRA Standards for treatment, storage, and

disposal of hazardous waste. The BIF Rule organizes sources using a three-tiered approach for each target pollutant. Current provisions under the BIF Rule mandate continuous emission monitoring for CO, O_2, and hydrocarbons based on this approach (EPA, 1992).

Tier I of the BIF Rule limits CO emissions to 100 ppmv (dry) based on an hourly rolling average corrected to 7% O_2. Monitoring hydrocarbon emissions is not required if the source can meet this criteria. If the source cannot meet this 100 ppmv Tier I CO limit, then hydrocarbon monitoring is required in addition to CO and O_2 monitoring. The source is also regulated under Tier II controls. Under Tier II, hydrocarbon emissions are limited to 20 ppmv (dry, corrected to 7% O_2) and CO emissions are limited based upon levels demonstrated during the compliance test. Concentrations of CO and hydrocarbons must be continuously monitored and corrected to 7% O_2 on a dry basis. CEM systems for CO and hydrocarbons must complete a minimum of one cycle of sampling and analysis every 15 seconds, and must record one data point each successive minute. The 60 most recent 1-minute averages must be used to calculate the hourly rolling average.

The current performance specifications for CEM systems at BIF sources are included in 40 CFR, Part 266, Appendix IX, Section 2. Section 2.1 outlines the performance specifications for CO and O_2 analyzers. Included are procedures for conducting calibration drift, relative accuracy, calibration error, and response time tests to assess the conformance of the CEM system with the specifications. The reference methods used for the relative accuracy determinations are Methods 3 or 3A (for O_2), and Methods 10, 10A, or 10B (for CO) in 40 CFR 60, Appendix A. Performance specifications for hydrocarbon analyzers are found in Section 2.2 of the BIF Rule. They specify the use of a heated flame ionization analyzer and sampling system maintained between 150-175°C, and include procedures for conducting calibration error, calibration drift, and response time tests. (Provisions are included also for the interim use of sample conditioning systems that cool and dry the stack gas sample prior to the analyzer.) Relative accuracy test requirements are not included in Section 2.2. Instead, procedures to challenge the analyzer and system with calibration gases are used to determine the conformance of the CEM system with the specifications.

2.1.4.2 Revised Standards For Hazardous Waste Combustors

Proposed revisions were published in the Federal Register on April 19, 1996 to 40 CFR Parts 60, 63, 260, 261, 263, 266, 270, and 271 with respect to the regulations for sources burning hazardous waste (61 FR 17358). The rule was proposed under the joint authority of the CAA and RCRA. The proposed rulemaking action was taken for two main reasons; 1) to meet scheduled MACT standards requirements, and 2) because of settlement requirements of a lawsuit between the agency and several other parties. The proposed rule revises standards for hazardous waste combustors, boilers and industrial furnaces, and lightweight aggregate kilns burning hazardous waste as supplemental fuels. MACT standards are proposed for dioxin/furans, mercury, semi-volatile metals (Cd, Pb), low volatile metals (Sb, As, Be, Cr), particulate matter, HCl, Cl_2, hydrocarbons, and CO.

The proposed rules reflect a multifaceted approach that establishes emission limits for dioxin/furans on a "toxic equivalent basis", uses hydrocarbons and CO as surrogates for volatile organic HAPs, and uses particulate matter as a surrogate for 1) non-dioxin/ furin semi-volatile organics and 2) both low and semi-volatile metals. No surrogates are proposed for mercury and HCl/Cl_2. The proposed rule contains monitoring requirements for CO and O_2 (all data must be corrected to 7% O_2), hydrocarbons, particulate matter, and mercury. Continuous monitoring of HCl/Cl_2 and other metals is optional.

New performance specifications to be included in Part 60 have been proposed as follows:

PS 4B for CO and O_2 for incinerators, boilers, and industrial furnaces burning hazardous waste (previously published in 56 FR 32688 July 17, 1991, with BIF regulations, but not previously designated as PS 4B.)

PS 8A for hydrocarbons THC for incinerators, boilers, and industrial furnaces burning hazardous waste (previously published in 56 FR 32688 July 17, 1991, with BIF regulations, but not previously designated as PS 8A.)

PS 10A mercury, semivolatile metals, and low volatile metals for incinerators, boilers, and industrial furnaces burning hazardous waste (new).

PS 11A continuous monitoring of particulate matter for incinerators, boilers, and industrial

furnaces burning hazardous waste (new but similar to ISO 10155).

PS 12A mercury emissions for incinerators, boilers, and industrial furnaces burning hazardous waste (new).

PS 13A HCl emissions for incinerators, boilers, and industrial furnaces burning hazardous waste (new).

PS 14A Cl_2 emissions for incinerators, boilers, and industrial furnaces burning hazardous waste (new).

Extensive discussions of EPA's determinations regarding the feasibility, availability, and performance of continuous monitors for organic compounds, metals, and particulate matter are included in the Technical Support Document 4A accompanying the proposed regulations. Many references to the experience with monitoring particulate and other components in Germany and Europe are included in the technical support documents and the preamble of the proposed regulations. EPA is conducting additional field evaluations for particulate and Hg monitors as the rulemaking proceeds.

2.1.5 Part 503 Sewage Sludge Incinerators

EPA promulgated CEM requirements for sewage sludge incinerators on February 19, 1993 in 40 CFR 503 under authority of the Clean Water Act. Subpart E of that regulation, §503.45, requires the installation of a total hydrocarbon (THC) monitor and an oxygen monitor on each incinerator. The THC monitor must use a sampling system maintained at a temperature above 150°C and a flame ionization detector. Monitoring results are corrected to 7% O_2, dry basis, and affected sources are required to comply with an emission limit of 100 ppm. Detailed guidance with respect to these regulations is found in "THC Continuous Emission Monitoring Guidance for Part 503 Sewage Sludge Incinerators" (EPA, 1994b). Performance specifications and quality assurance procedures are modified from those in Part 60. No relative accuracy test involving independent THC measurements is required. Instead, these regulations rely on the use of calibration gases to assess the performance of the measurement system.

In response to certain petitioners, EPA published a modification to the sewage sludge incinerator monitoring requirements on February 25, 1994 (FR 9097). In this action, EPA agreed that a 100 ppm CO standard imposed by the state of New Jersey was more restrictive than the 100 ppm THC standard. EPA's amendment removed the THC requirement for those sources that install a CO monitor and can demonstrate continuous compliance with a 100 ppm CO standard (monthly average).

2.2 State and Local Agency Programs

Most state and local air pollution control agencies have broad authority to specify emission monitoring and test methods. Monitoring requirements may be adopted through applicable rulemaking procedures for certain source categories or they may be included in operating permits for individual sources on a case-by-case basis. Source-specific monitoring requirements are included in compliance orders or consent decrees as a result of enforcement activities.

On October 6, 1975 (FR 40 46247), EPA established requirements for states to adopt and implement continuous emission monitoring programs in state implementation plans designed to achieve conformance with ambient air quality standards. These requirements are contained in Appendix P to Part 51 - "Minimum Emission Monitoring Require-ments." These minimum requirements identify affected source categories; prescribe monitoring, recording and reporting procedures for those sources; and detail performance specifications and procedures for converting monitoring data to units of the state emission standard. Appendix P states,

> "Such data must be reported to the State as an indication of whether proper maintenance and operating procedures are being utilized by source operators to maintain emission levels at or below emission standards. Such data may be used directly or indirectly for compliance determination or any other purpose deemed appropriate by the State."

Appendix P addresses: opacity, SO_2 and NO_x monitors (and diluent oxygen or carbon dioxide monitors) for certain fossil fuel-fired steam generators, opacity CEM systems for fluid bed catalytic cracking unit regenerators, SO_2 monitors for sulfuric acid plants, and NO_x monitors for nitric acid plants.

The minimum requirements included in Appendix P apply to opacity and criteria pollutant monitors at fossil fuel-fired steam generators, sulfuric acid plants, and nitric acid plants. Some states and local agencies have required CEM systems for additional sources and additional pollutants. In many cases, these regulations are similar to the requirements outlined in Appendix P.

2.2.1 State and Regional Initiatives

State and local air pollution control agencies have included continuous emission monitoring requirements in regulations and in permits for specific facilities. With respect to non-criteria pollutant monitors, many of these requirements are on a case-by-case basis. The following are some examples. New Jersey, Virginia, and Rhode Island have required installation of ammonia monitors at certain cogeneration or combined cycle turbine installations where NO_X control is required. A municipal waste combustor facility in Connecticut is conducting an evaluation of an installed HCl monitor to demonstrate that SO_2 removal efficiency across a spray dryer is an adequate surrogate for HCl emissions; the state agency is determining the viability of HCl monitors based on the same study (Anderson, 1996). Another HCl CEM system is installed at a resource recovery facility in New Jersey in response to a permit requirement (Ballay, 1996). FTIR monitoring systems are installed and reporting data at a hazardous waste incinerator in New Jersey. Additionally, a prototype gas chromatograph continuous monitoring system measuring multiple organic compounds is installed at a printing facility in North Carolina (Davis, 1996). Some of these installations, and many others, are installed on a trial basis; future requirements may depend on the experience that is gained in these efforts.

Three example state/regional initiatives are described below which represent a range of CEM applications and programs. These examples differ from the previously described federal regulatory programs and illustrate alternative approaches, performance specifications, problems, and solutions that may be useful in other applications.

2.2.1.1 Pennsylvania Non-Criteria Pollutant Monitoring

The Commonwealth of Pennsylvania has taken a somewhat unique approach to the development and implementation of CEM requirements. Pennsylvania's requirements reflect differences in the technical specifications, performance test procedures, and reference test methods for criteria and non-criteria pollutant monitoring. The requirements are contained in, "Continuous Source Monitoring Manual" Revision No. 6 (Commonwealth of Pennsylvania, 1996).

The Continuous Source Monitoring Manual contains CEM requirements for 1) submittal and approval, 2) recordkeeping and reporting, and 3) quality assurance. The submittal and approval process includes Phase I - Initial application, Phase II - Performance testing, and Phase III - Final approval. Detailed requirements for submission of the initial application are provided; the initial application must be approved prior to initial startup of new source and within six months of promulgation of monitoring requirements for existing sources. Performance Specifications for opacity, SO_2, NO_x, O_2, and CO_2, CO, TRS and H_2S, and HCl monitors are provided. In addition, performance specifications are provided for coal sampling, stack gas flow monitors, temperature rate monitors, "pollutants not listed elsewhere" and "parameters not listed elsewhere." For gas pollutant and diluent monitors, performance specifications are included for 1) relative accuracy, 2) calibration error (three points), 3) 24-hour zero and calibration drift, 4) 2-hour zero and calibration drift, 5) response time, 6) operational test period, and 7) data system accuracy. These are more comprehensive specifications than are included in EPA performance specifications. Unique to Pennsylvania is a requirement to verify the performance of opacity monitoring systems by comparison to visual opacity readings. Also unique to Pennsylvania is the requirement to evaluate data system accuracy by comparing "manual calculations" based on monitoring values with data acquisition system output. Installation specifications establishing span value, range, data recorder resolution (% of span and time), measurement cycle time, frequency of zero and calibration checks, and other requirements are also included. Pennsylvania requirements for HCl monitors and "parameters not listed elsewhere" are reproduced herein as Tables 2-6 and 2-7, respectively.

As with performance specifications, CEM quality assurance requirements in Pennsylvania are somewhat more extensive than federal requirements. For example, three-point calibration error tests are required to be performed each calendar quarter. Detailed procedures are included for establishing the values of the calibration standards used for daily checks and for periodic audits. An annual relative accuracy test is required. Also, annual review of the quality assurance plan and quality assurance results by the source operator is required for every facility. Pennsylvania requirements detail criteria to determine when monitoring data are invalid and additional criteria to identify valid periods of data.

Non-criteria pollutant monitoring required in Pennsylvania includes HCl monitors on municipal waste combustors, TRS monitors at pulp and paper facilities, H_2S monitoring in petroleum refinery fuel gas, and various parameter monitoring applications. As with criteria pollutant monitoring, the data are used to assess monetary penalties for excess emissions

Table 2-6. Pennsylvania Specifications for Hydrogen Chloride Continuous Emission Monitoring Systems

Type	Parameter	Specification
Install	Span Value (nearest ppm equivalent)	2.0 times lowest std or as specified in federal regulations
	Range (ppm)	0 to > = max. expected and (> = 1.25 x highest std.)
	Data recorder resolution (% of lowest std.)	1.0 maximum **
	Data recorder resolution (minutes)	5 maximum **
	Number of cycles per hour (meas. and record)	12 minimum **
	Schedule for zero and calibration checks	daily minimum
	Procedures for zero and calibration checks	all system components checked
	Calibration gas ports	close to sample point
Perform	Relative accuracy in terms of standard	
	either (% of reference method)	20 maximum *
	or (% of standard)	10 maximum *
	or (abs ppm for ppm stds)	5 maximum
	or (abs % for % reduction stds)	2.0 maximum
	Calibration error (% of actual concentration)	5 maximum *
	or (abs ppm)	1 maximum
	Zero drift - 2 hour (% of span)	4 maximum *
	Zero drift - 24 hour (% of span)	5 maximum *
	Calibration drift - 2 hour (% of span)	4 maximum *
	Calibration drift - 24 hour (% of span)	5 maximum *
	Response time (minutes to 95% response)	5 maximum
	Operational test period (hours without corrective maintenance)	168 minimum
	Data acquisition system accuracy, 1-hour avgs (%of lowest std)	1 maximum ***

* Expressed as the sum of the absolute value of the mean and the absolute value of the 95% confidence coefficient.
** Must meet most stringent requirements of other analyzers in CEM system (except temperature).
*** If data recording is digital, expressed as the absolute value of the mean. If data recording is analog, expressed as the absolute value of the mean and the absolute value of the 95% confidence coefficient.

Table 2-7. Pennsylvania General Parameter Source Monitoring Specifications

Type	Parameter	Specification
Install	Span Value (terms of measurement)	2.0 times lowest std or as specified in federal regulations
	Range (terms of measurement)	0 to > = max expected & (> = 1.25 x highest std)
	Schedule for zero and calibration checks	daily minimum *
	Procedures for zero and calibration checks	measurement simulation if possible, otherwise signal simulation *
	Calibration point	close to measurement point *
	Data recorder resolution (% of lowest std)	1.0 maximum **
	Data recorder resolution (minutes)	1 maximum **
	Number of cycles per hour (meas. and record)	60 minimum **
Perform	Calibration error (% of actual measurement or simulated signal)	5 maximum ***
	Zero drift - 24 hour (% of span)	2.5 maximum ***
	Calibration drift - 24 hour (% of span)	2.5 maximum ***
	Response time (minutes to 95% response)	equal to recorder resolution
	Operational test period (hours without corrective maintenance)	168 minimum
	Data acquisition system accuracy, 1-hour avgs (% of lowest std)	1 maximum ****

Specifications for parameters not listed elsewhere, based on basic measurements of length, mass, time, temperature, current, luminous intensity or events, or derived from such basic measurements (for instance, volume rate, mass rate, velocity, force, pressure, torque, rpm, voltage, resistance, spark rate, etc.). For use only when specified or allowed by an applicable monitoring requirement, or when necessary to convert data to terms of the applicable standard or operational criterion.

* This requirement may be waived if quarterly recalibration of the measurement device/readout device combination is conducted by National Institute of Standards and Technology (NIST) or by a lab using NIST procedures each calendar quarter.
** Must meet most stringent requirements of other analyzers in CEM systems (except temperature)
*** Expressed as the sum of the absolute value of the mean and absolute value of the 95% confidence coefficient.
**** If data recording is digital, expressed as the absolute value of the mean. If data recording is analog, expressed as the absolute value of the mean and the absolute value of the 95% confidence coefficient.

and for poor CEM performance (i.e., monitor downtime). Penalties for excess emissions depend on both the magnitude and duration of periods when the applicable emission standard is exceeded. Quarterly monitoring reports must be certified by the source operator. Electronic data reporting formats and telemetry protocols are specified also.

2.2.1.2 NESCAUM CEM Guidelines for Municipal Waste Combustors

The Northeast States for Coordinated Air Use Management, (NESCAUM) is an organization supported by a group of eight states: Maine, New Hampshire, Connecticut, Massachusetts, Rhode Island, Vermont, New York, and New Jersey. NESCAUM facilitates projects where the participating states pool expertise and resources to address specific air pollution problems. NESCAUM formed a workgroup to develop CEM guidelines for municipal waste combustors because of the number and impact of these facilities being constructed in the northeastern United States prior to the EPA's promulgation of Part 60 Subpart Ea regulations for these sources. In 1990, NESCAUM published "CEM System Performance Specifications and Quality Assurance Requirements for Municipal Waste Combustors" (Peeler, 1990). This guideline document is signifi-cant because: 1) more extensive procedural and technical requirements are recommended than are included in the federal regulations for SO_2, NO_x, CO, and opacity CEM systems, and 2) specific performance specifications and quality assurance requirements are recommended for HCl CEM systems.

NESCAUM CEM recommendations were specifically developed to address technical monitoring problems that are encountered at municipal waste combustors and the needs of the participating states. Technical monitoring problems include low emission levels at the control device outlet and widely fluctuating emission levels (intermittent spikes) in CO and SO_2 concentrations at some sources. Major differences in the NESCAUM performance specifications relative to the existing Part 60 regulations were: 1) requirements that gas CEM systems use calibration gases for drift checks and daily checks, 2) requirements for quantitative determination of the calibration gas values, 3) four-point linearity tests for all gas monitors, 4) an additional minimum absolute accuracy specification was included to reflect limitations of the monitoring equipment, reference methods, and relative accuracy test in certain cases, and 5) cycle time/ response time specifications were added for all monitors. The absolute accuracy specification is a mean difference of 5 ppm (10 ppm for CO monitors) during the relative accuracy test and reflects the collective limitations of monitoring equipment and reference methods. The limitations of the relative accuracy test at low pollutant concentrations also are contained in this specification. This specification is included in addition to the PS 2 relative accuracy specifications of $\leq$20 percent of the reference value or $\leq$10 percent of the emission standard for SO_2 and NO_x monitors, and similar limits for CO monitors. EPA subsequently included a 10 ppm mean difference accuracy specification in PS 4A for CO monitors at municipal waste combustors. However, similar revisions to PS 2 or PS 3 were not made.

Along with additional and modified specifications, the NESCAUM CEM guidelines include substantive procedural changes to the performance specification test procedures that address specific problems which have occurred during field performance tests. For example, controversy had arisen regarding the validity of performance test results in cases where monitor vendors performed numerous adjustments during the test period and where "normal operating procedures" had not been established for newly installed CEM systems. The NESCAUM guideline document includes recommendations to resolve these issues by requiring source operators to establish prior to the test; 1) criteria for adjusting monitor calibration, 2) criteria and schedules for routine maintenance, and 3) the frequency and criteria for additional checks of monitoring equipment.

Major differences in the NESCAUM QA require-ments relative to the Part 60 regulations are: 1) source operators must develop and submit a preliminary monitoring plan, 2) QA plans are required for all sources and detailed guidance on QA plan content is provided, 3) an annual review of QA plans by the source operator is required, 4) a four-point linearity test is required to be performed each calendar quarter, 5) a relative accuracy test is required once per year and must be performed immediately before or after the quarterly linearity test, and 6) minimum data availability specification (90 percent of source operating time) is included.

2.2.1.3 SCAQMD RECLAIM Program

Since the passage of the 1990 Clean Air Act Amendments, the South Coast Air Quality Management District has been involved in the development of Regional Clean Air Incentives Market, or "RECLAIM" program. This innovative market-based program was developed as an alternative to the traditional "command and control" approach in an effort to achieve

air pollution emissions reductions in a more cost effective and efficient manner. The evolution of RECLAIM and its objectives are discussed by Lents (Lents, 1996). RECLAIM is an example of what has become known as a "cap and trade" program.

A number of fundamental issues addressed in RECLAIM are applicable to other cap and trade programs. These include: 1) determining the exact population of sources included in the program (pollutants, source categories, size thresholds, exemptions, etc.), 2) determining the "cap" or total emissions allowed for pollutants and determining how the cap is to decrease over time to achieve necessary emission reductions, 3) determining how permitted emissions are to be allocated amongst the population of sources initially, and over time, and establishing baselines for historic emissions, 4) determining how emissions are to be measured by the affected sources and monitored by the agency to provide an accurate, reliable, and systematic basis for trades, 5) developing trading mechanisms that would encourage rather than inhibit the process, 6) reconciling the trading program with other applicable regulations for the populations of sources, and 7) changing the procedures used to issue permits and enforce regulations and permit conditions.

RECLAIM originally was intended to apply to emissions of NO_x, SO_2, and VOCs. During the development of the program, SCAQMD decided to postpone the VOC program because: 1) technical difficulties are encountered in attempting to quantify these emissions (few historical quantitative measurements, many small sources and many fugitive emission points), 2) some of the VOC compounds also are classified as hazardous pollutants and thus, different regulatory considerations apply, 3) different VOCs participate to different extents in reactions to form ozone, and 4) the workload associated with the program was too great, even after eliminating consideration of the VOCs. SCAQMD is now attempting to implement RECLAIM for NO_x emissions from 370 facilities and SO_2 emissions from 40 facilities. All of these facilities are required to install CEM systems to quantify their SO_2 and NO_x emissions. Measurement data are averaged and 15-minute values are calculated by remote terminal units at each facility. Data are transmitted electronically to a central AQMD computer. The computer is programmed to deploy an inspector when a problem is indicated at a particular facility.

RECLAIM represents a comprehensive program that deals with many complex issues even for monitoring of criteria pollutants. Even greater technical challenges must be overcome to apply such an approach to non-criteria pollutants.

2.2.2 Compliance Assurance Monitoring (CAM) Program

Before the 1990 Clean Air Act Amendments, EPA and some state and local agencies had concerns that some air pollution sources were not in compliance with applicable regulations resulting in adverse air quality impacts. The 1990 CAAA requires EPA to develop regulations for permitted sources to enhance air pollution monitoring and certify compliance with air pollution regulations. Permit regulations in Part 70 require certain sources to perform periodic monitoring and to submit annual certifications of compliance. In October of 1993, the EPA proposed the Enhanced Monitoring Program (58 FR 54648-54699). This proposed program was to require all major sources subject to federally enforceable requirements to develop procedures and methods that continuously demonstrate compliance with emission standards. Data from enhanced monitoring were to be viewed as "presumptively credible evidence" for use in the enforcement of regulations. Thus, various performance specifications and quality assurance requirements were also proposed. The proposed enhanced monitoring program fundamentally changed the compliance methods for many sources and was expected to impose great financial burden on both regulated sources and air pollution control agencies.

The enhanced monitoring rule was withdrawn in April of 1995 and the EPA subsequently drafted the compliance assurance monitoring program (CAM). The draft CAM rule was released in September of 1995 and a second draft was released on August 2, 1996. (See the EPA TTN BBS, phone 919-541-5742.) According to the accompanying announcement, the CAM program attempts to build on existing regulatory monitoring approaches by focusing on "providing a reasonable assurance of compliance with emission limits by monitoring that ensures control measures are operated and maintained in a manner consistent with good air pollution practices." The CAM rule is intended to satisfy the periodic monitoring requirements in Part 70 and the enhanced monitoring requirements in the 1990 CAAA. According to EPA, the proposed CAM rule will cover about 60 percent of the emission units with control equipment and 20 percent of all other emission units.

Where continuous compliance monitoring is required, the draft CAM rule exempts the source from additional monitoring. For affected units with control equipment, the source must develop and comply with a CAM plan. The CAM plan is to include operating indicator ranges for control equipment that represent good air pollution control practices that minimize emissions. Excursions beyond these indicator ranges trigger prompt corrective action. An excessive duration of excursions requires more intensive evaluation, corrective action, and requires notification to the permitting authorities of potential compliance problems.

The CAM rule does not require sources to install CEM systems, so few sources are expected to do so as a result of this rule. Depending upon the specific requirements included in the final rule, and the outcome of other rule making efforts (such as the "credible evidence" rule), some sources may find opacity or other pollutant monitors advantageous. EPA has indicated that explicit requirements to satisfy enhanced and periodic monitoring of hazardous air pollutants will be included in future Part 63 NESHAP standards.

2.2.3 Open Market Trading

The 1990 CAAA encourages the use of market-based approaches, including emission trading to assist in achieving ambient air quality standards. Market-based trading programs are intended to provide incentives for sources to reduce emissions beyond applicable requirements and encourage early emission reductions and technological innovations to reduce and measure emissions.

Emissions trading systems may be categorized as being either "open" or "closed." Examples of "closed market" programs are the EPA Acid Rain Allowance Trading Program and the SCAQMD RECLAIM program. In closed markets, emission trading is restricted to a defined population of sources, total emissions are limited, or "capped" (which may decrease with time to achieve overall reductions), and portions of the total allowed emissions are allocated among the affected sources.

In contrast, open market trading programs involve voluntary participation, may include diverse types of sources, and are designed to be compatible with existing regulations. These trading programs typically involve the exchange of discreet, quantifiable emission reduction credits between sources with some portion of the reduction "retired" to provide for improved air quality. Open market trading programs also may involve banking of emission reductions for use at a future date. The fact that open market trading allows for the exchange of emissions both over time and between sources distinguishes this approach from emissions averaging between sources. Open market trading programs may be very flexible and avoid many of the problems associated with establishing baseline emissions and allocating emission allowances among a specific population of sources.

On July 26, 1995, the EPA administration signed "Open Market Trading Rule for Ozone Smog Precursors: Proposed Policy Statement and Model Rule (USEPA, 1995b)." The preamble discusses many aspects of open market trading approaches as they apply to NO_x and VOC monitoring. An important aspect of these programs are the measurement protocols used to quantify the discreet emission reductions (DER) that are bought and sold. The DER must be "real, surplus, and verifiably quantified" according to the preamble of the model rule. Measurement protocols may include a wide range of inputs including emission factors, engineering calculations, periodic source testing, predictive emissions models, and CEM systems. The model rule allows for states to adopt these programs and facilitates their rapid approval by EPA.

Michigan, Texas, New Jersey, New York, and Virginia have developed, or are developing, open market trading programs. NESCAUM/MARAMA, Northeast States for Coordinated Air Use Management/ Mid-Atlantic Regional Air Management Association) have undertaken a project to encourage interstate open-market trading of NO_x and VOC emissions. NESCAUM/MARAMA have developed a series of measurement protocols that involve determining baselines, applying emission factors, and using CEM systems.

The Michigan Department of Environmental Quality (DEQ) has specified some characteristic elements of DERs (called Emission Reduction Credits (ERCs) in Michigan). "ERCs must be:

1) surplus, in that reductions are not required by any applicable requirement;
2) real, in that all emission reductions have actually occurred;
3) quantifiable, in that all reductions can be measured and are replicable;
4) enforceable, in that they can be enforced by both DEQ and EPA; and

5) permanent, in that the reductions were continuous during the time the ERCs were generated."

The viability of open market trading programs for VOCs that rely on continuous monitoring of emissions present several challenges. Where a monitoring system providing a "total response" (as opposed to speciating particular organic compounds) is used, assumptions regarding the composition of the VOC emissions may be necessary to account for varying instrument response factors of the instrument for different compounds. In addition, assumptions are also necessary to estimate the molecular weight used in calculating emissions on a mass basis. Additional considerations apply because many VOCs are also hazardous air pollutants and because emission reduction credits for hazardous compounds can not be applied to achieve compliance with NESHAP (MACT standards). Finally, an equitable basis for the exchange of VOC emission reductions may need to consider that different compounds participate to different extents in reactions leading to the formation of ozone. The decision-maker considering participation in an emission trading program for VOCs or other non-criteria pollutant must seek resolution of these issues with the applicable control agency.

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