Part 75 CEMS Field Audit Manual

Clean Air Markets Division
U.S. EPA
Washington, DC 20014

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Acknowledgments

This Part 75 CEMS Field Audit Manual is the result of past U.S. EPA documents, as well as significant support and reviews to provide updated information. The Clean Air Markets Division (CAMD) of the U.S. EPA had prepared an "Acid Rain Program CEMS Field Audit Manual" to assist with auditing continuous emission monitoring systems (CEMS) installed under 40 CFR Part 75. In addition, Joseph Winkler, U.S. EPA Region VI, with contractor assistance from Gerhard Gschwandtner, Comprehensive Monitoring Services, Inc., had prepared a separate "Acid Rain Program: Continuous Emission Monitoring Systems Reference Manual." Dr. James Jahnke, of Source Technology Associates, prepared EPA's 1994 document entitled "An Operator's Guide to Eliminating Bias in CEM Systems" (EPA 430-R-94-016). Additional references used in developing this manual are listed at the end of Section 2. The Clean Air Markets Division acknowledges the authors of these existing documents for providing a valuable foundation for preparing this document.

The CAMD team leader for this manual was Matthew Boze. Other CAMD staff provided valuable support and comments, including Louis Nichols and others in the Emission Monitoring Branch. Contract support for this document was provided by Perrin Quarles Associates, Inc. under Purchase Order No. 2W-1382-NTSA. James Jahnke, Ph.D., Source Technology Associates, and James Peeler, Emission Monitoring, Inc., provided a technical review of a draft of this manual. Other reviews were provided by Joseph Winkler, EPA Region VI, and Errin Pichard, Florida Department of Environmental Protection.

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Part 75 CEMS Field Audit Manual

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Section 1: Introduction

After reading this Introduction, the inspector (auditor) should understand the organization of the manual and the topics it covers, the role of the field audit in the Part 75 compliance program, the key components of the field audit, and where to obtain the latest information on the regulation and on manual updates.

1.1 Background

1.1.1 Importance of Monitoring for Emission Trading Programs

The U.S. Environmental Protection Agency (EPA) has established monitoring requirements at 40 CFR Part 75 as part of its efforts to develop cap and trade emission reduction programs. A cap and trade program is an innovative, market-based approach to reducing emissions. The "cap" sets a ceiling on emissions that is below an applicable baseline level. Sources in the program receive emission "allowances," with each allowance authorizing a source to emit one ton of the pollutant being controlled. Limiting the number of available allowances ensures the cap's integrity. At the end of each year, every source must have enough allowances to cover its emissions for that year. Unused allowances may be sold, traded, or saved (banked) for future use. While this approach allows sources flexibility in deciding how they achieve compliance, the cap ensures that the affected sources reduce emissions collectively to the desired reduction goal.

The cornerstone for ensuring that sources achieve the required emission reductions is a strong monitoring program. Accurate monitoring of all emissions and timely reporting ensure that a ton from one source is equal to a ton from any other source and that the integrity of the cap is maintained. Under Part 75, participating sources must fully account for each ton of emissions according to stringent, uniform protocols. The resulting compliance information is unprecedented in its accuracy and comprehensiveness. All data are publicly available on the Internet, providing complete transparency.

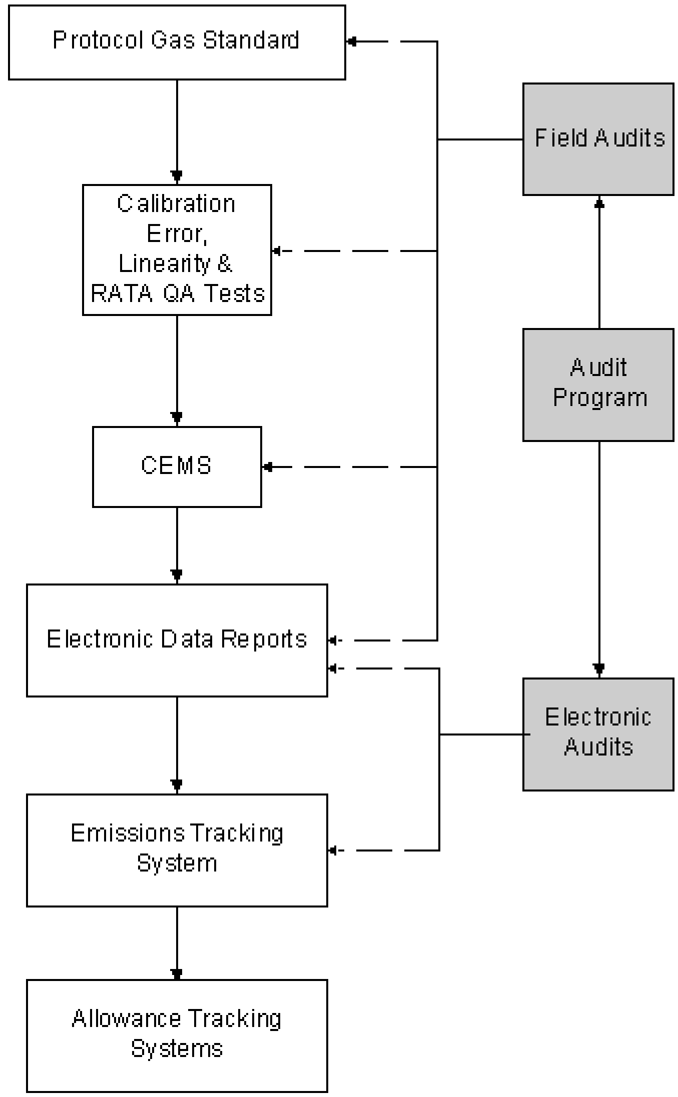
To date, the Part 75 monitoring requirements are used for two separate programs. Under the Acid Rain Program, sources have had to meet Part 75 and emission reduction requirements since 1995. EPA has had the lead in ensuring compliance with the Acid Rain Program, although EPA has teamed with State and local agencies on various aspects of implementing the Part 75 monitoring provisions.

In May 2002, State agencies began to take the lead role in implementing and ensuring compliance with Part 75 for purposes of a separate nitrogen oxides (NO_x) trading program that many eastern States have adopted in response to EPA's 1998 NO_x SIP Call. EPA believes that a strong audit program is an essential component of an effective Part 75 compliance oversight program. Given the increased role of State and local agencies in Part 75 implementation, EPA has prepared this manual to assist agencies in implementing Part 75 and to ensure the ongoing integrity of the new NO_x trading program.

The manual begins with the premise that each link in the chain of the Part 75 program is important in ensuring that the data ultimately used to measure emissions and account for the use of allowances in a trading program remain accurate. Illustration 1-1 depicts the major links in the data quality chain for a continuous emissions monitoring system (CEMS). The process starts with ensuring that the gas standards used to calibrate and test the monitoring equipment are accurate. EPA adopted the Traceability Protocol for Assay and Certification of Gaseous Calibration Standards for this purpose. The source must conduct the necessary quality assurance tests following all appropriate procedures and report the results of those tests accurately. These quality assurance activities are conducted initially for certification and then on an ongoing basis to maintain a measure of the system's ability to accurately determine emissions. Once the data measurements are quality-assured, the next step is to ensure that the measured data obtained from the CEM analyzer are accurately recorded by the data acquisition and handling system (DAHS) and appropriately reported in the quarterly electronic data reports (EDR). The EDRs are submitted quarterly to EPA so that it can review and account for the emissions data in the cap and trade program. EPA provides the necessary data management systems to track emissions and allowance transfers.

The integrity of the overall trading program can break down anywhere along this chain of activities, therefore EPA relies on a combination of electronic and field auditing to verify overall data integrity. The field audit procedures in this manual are critical for examining these links to verify proper performance of the monitoring systems and identify problems which may lead to inaccurate emissions accounting.

Illustration 1-1:
Overview of Continuous Emission Monitoring in a Part 75 Trading Program



1.1.2 Structure of Part 75 Monitoring Provisions

Continuous emissions monitoring systems (CEMS) are the primary monitoring method under Part 75. The Part 75 rule includes requirements for installing, certifying, operating, and maintaining CEMS for SO_2, NO_x, CO_2, O_2, opacity, and volumetric flow. Appendices A and B of Part 75 provide the technical specifications for the installation and performance of CEMS, including certification and quality assurance test procedures. The rule also includes approved non-CEMS options for certain gas and oil fired units, and procedures to account for missing data.

Recordkeeping and reporting provisions require Acid Rain Program and NO_x trading program affected units to submit Part 75 hourly emission data and related quality assurance data through electronic report formats to EPA's Emission Tracking System (ETS) which is operated by the Clean Air Markets Division (CAMD). The ETS data in turn are used to maintain the emission allowance accounts in the Allowance Tracking System and the NO_x Allowance Tracking System.

> **TIP!**
>
> Check **www.epa.gov/airmarkets** for further regulatory information

The Part 75 requirements are outlined below to introduce you to the rule and some of the terminology used in the manual. You can obtain copies of Part 75 and determine whether EPA has published further revisions to Part 75, issued new monitoring guidance, or revised the information in this manual by checking CAMD's website. Section 1.5 of the manual provides a list of important regulations and policy guidance documents, with links to specific pages on CAMD's website you may find helpful.

Monitoring Methods

The monitoring requirements for each type of unit subject to Part 75 are in Subpart B of the rule. CEMS are required except for some gas and oil fired units. Table 1-1 summarizes CEMS components that are required by pollutant, while Table 1-2 summarizes the non-CEMS options.

Table 1-1:
Part 75 Pollutants/Parameters and CEMS Components

	Required CEMS Components					
Pollutant/Parameter	**SO_2**	**NO_x**	**Flow**	**Opacity**	**Diluent Gas (O_2 or CO_2)**	**Data Acquisition and Handling System (DAHS)**
SO_2 (lb/hr)	✔		✔			✔
NO_x (lb/mmBtu)[1]		✔			✔	✔
NO_x (lb/hr)[2]		✔	✔		✔	✔
Opacity (%)[3]				✔		✔
CO_2 (lb/hr)[4]			✔		✔	✔
Heat Input (mmBtu/hr)			✔		✔	✔

[1]Heat input in mmBtu/hr is also required.
[2]For units subject to NO_x SIP Call trading program. Can monitor with or without diluent monitor.
[3]Required only for coal and residual oil units.
[4]Alternative mass balance method may by used to monitor CO_2.

Table 1-2:
Part 75 Non-CEMS Methodologies

Pollutant/ Parameter	Unit Type	Monitoring Methodology
SO_2 (lb/hr)	natural gas	Default SO_2 emission rate combined with measured fuel flow. (Part 75, Appendix D)
SO_2 (lb/hr)	gas or oil	Fuel sampling and analysis combined with measured fuel flow. (Part 75, Appendix D)
NO_x (lb/mmBtu), NO_x (lb/hr)	gas or oil peaking units	Estimate NO_x rate by using site-specific emission correlations with measured fuel flow if measuring lb/hr. (Part 75, Appendix E)
SO_2, CO_2, NO_x (lb/hr for all, and lb/mmBtu for NO_x)	gas or oil	Conservative default values for units with low mass emissions. (§ 75.19)
Heat Input (mmBtu/hr)	gas or oil	Measured fuel flow and GCV. (Part 75, Appendix D)

Monitoring Certification Requirements

The implementing agency must certify an allowable monitoring method before it can be used for Part 75 monitoring. The source must perform certification tests and submit the results to EPA and the appropriate State agency. Part 75 performance certification testing is outlined in § 75.20 and Appendix A, § 6. Certification tests for a CEMS may include:

- 7-day calibration error test for each monitor
- Linearity check for each pollutant concentration monitor
- Relative Accuracy Test Audit (RATA) for each monitoring system
- Bias test for each monitoring system
- Cycle time test for each pollutant concentration monitor
- Daily interference test for flow monitors
- DAHS testing

There are also certification requirements for non-CEMS methods. These include accuracy tests for fuel flow monitors (§ 75.20 and Appendix D, § 2.1.5), stack tests to develop NO_x correlations for gas or oil peaking units (Appendix E, § 2.1), or unit-specific default values for low mass emissions units (§§ 75.19-75.20).

Recertification may be required if the facility replaces, modifies, or changes a certified CEMS in a way that may significantly affect the ability of the system to accurately measure monitored parameters.

Quality Assurance/Quality Control Procedures

The source is required to develop and implement a written quality assurance/quality control (QA/QC) plan for each monitoring system (§ 75.21). The QA/QC plan must include procedures for system operation, as well as procedures for conducting quality assurance tests (QA tests), preventive maintenance, and recordkeeping. Appendices A and B to Part 75 describe the technical procedures for how and when to conduct periodic QA tests, which include:

- Daily calibration error tests: Challenge a gas CEMS at a zero and high level with calibration gas.
- Daily interference tests for flow monitors: Follow procedure to detect plugging or other problems that could interfere with a flow monitor.
- Quarterly linearity tests: Challenge a gas CEMS at 3 levels with calibration gases.
- Quarterly flow-to-load evaluations: Compare flow monitor values to values from an initial flow-to-load correlation as a means to check flow monitor data quality over time.
- Semi-annual or annual RATAs: Compare monitored values to values measured by an approved EPA reference method. Also, use RATA results to detect and, if necessary, adjust for low bias.

Recordkeeping and Reporting

Part 75 includes requirements for notifications, recordkeeping, and reporting in Subparts F and G. As noted earlier, most of the reporting to EPA is done electronically every quarter in a standard electronic format, and much of the recording will be done automatically using the DAHS. Some important records and reporting that you will want to review include:

- Monitoring plan: Submitted electronically, although some information is submitted only in hardcopy. Contains information describing the unit, CEMS, other monitoring methodologies, and specific calculation procedures.
- Hourly parameters, including emissions, flow, heat input, monitor availability, and other information.
- Periodic QA test results.
- Recertification tests.
- Other records that are required to be kept on-site such as:
    - -- Annual span/range evaluation.
    - -- SO_2 scrubber parameters to verify proper control operation during a missing data period.

Missing Data

Part 75 requires sources to account for emissions during periods when there are no valid data (missing data periods) due to the monitor not operating or operating out of control. The missing data methodologies are necessary so that a source accounts for emissions during each hour of operation. The missing data algorithms become increasingly conservative as monitor downtime increases so that sources have an incentive to maintain high data availability.

1.2 What does the manual cover?

This manual details recommended procedures for conducting a field audit of a Part 75 monitoring system. Included are: tools you can use to prepare for an audit; techniques you can use to conduct the on-site inspection and review records; proper methods for observing performance tests; and guidelines for preparing a final report. EPA has designed the audit procedures in this document so that personnel with varying levels of experience can use them.

While the manual is written primarily for State and local agency inspectors, industry personnel may find some of the material useful for their internal data quality management activities.

The manual covers gas (SO_2, NO_x, and diluent) and flow monitoring systems -- it does not cover opacity monitor audits. Although Part 75 requires opacity monitors for coal-fired units subject to the Acid Rain Program, opacity data and quality assurance tests are not reported to CAMD in quarterly emission data reports. Moreover, the source can comply with Part 75 by satisfying performance specifications in Part 60 that are generally applicable to opacity monitors and can follow a State's recording and reporting requirements. Thus, there are no special Part 75 audit techniques for these systems.

The manual is organized into eight major sections, with one appendix:

- **Section 1** introduces cap and trade programs, Part 75, the role of field audits and the inspector, CAMD's audit targeting role, the importance of inspector training, and a list of key Part 75 materials with Internet links.

- **Section 2** provides a short introduction to the various types of CEMS and the major components of a CEMS, including basic installation and operating principles.

- **Section 3** describes preparing for an audit prior to the plant visit, with emphasis on using CAMD's Monitoring Data Checking (MDC) software to review the electronic data.

- **Section 4** covers the on-site CEMS inspection, including what to look for and questions to ask during a walk through of CEMS components, as well as how to review the QA/QC plan and other in-plant records.

- **Section 5** describes how to observe CEMS performance tests (linearity and relative accuracy test audits).

- **Section 6** outlines specific on-site review procedures for Appendix D and E monitoring systems and records.

- **Section 7** guides you in conducting the exit interview and preparing a written audit report.

- **Section 8** discusses issues that should be considered by a State or local agency in developing a performance testing program, with an emphasis on single gas challenges and linearity tests.

- **Appendix A** to the Manual provides sample checklists for the field audit, RATA, and linearity observations. The checklists are based on the discussions and techniques in Sections 3 through 6.

1.3 Part 75 Audit Program Overview

The Part 75 audit program consists of both electronic audits and field audits. CAMD uses automated tools such as the Monitoring Data Checking (MDC) system to conduct automated checks of data submitted under Part 75 for potential problems. Also, it uses its data systems and its ability to check data through automated information systems to target units for follow-up data audits. On-site field audits performed to ensure that monitoring systems are installed and operated properly are also essential in the Part 75 audit program.

1.3.1 Part 75 Electronic Audit Program

CAMD performs routine electronic audits on each quarterly report submittal using the ETS and MDC software. EPA may also perform targeted electronic checks to find other specific data reporting problems. The electronic audits identify errors in the quarterly electronic data report, the monitoring plan, and the QA tests. An automated ETS feedback report that focuses on the reported emissions data is sent to the source instantly upon electronic submittal by ETS. EPA then uses MDC to analyze the monitoring plan and QA data, and sends an MDC feedback report at the end of the quarterly submission period. The reports categorize errors as critical and non-critical -- for critical errors, the source must correct and resubmit the quarterly report.

1.3.2 Audit Targeting

In addition to performing electronic audits, EPA periodically compiles a recommended field audit target list based on a review of all of the quarterly electronic data reports. This national list attempts to identify trends based on a large population of units that may not be identifiable from a smaller population at the State level alone. The target list is intended to help States allocate their auditing resources on those units that are most likely to have data problems based on the findings of EPA's electronic auditing efforts. States may use these recommendations to focus their audit efforts, but may also choose other units for field audits through State targeting approaches or at random.

1.3.3 Field Audits

EPA relies on State and local agencies to conduct field audits of monitoring systems to assess the systems performance and a source's compliance with monitoring requirements. The audits also encourage good monitoring practices by raising plant awareness of monitoring requirements. The field audit consists of a thorough evaluation of the CEMS via pre-audit record review, on-site inspection of equipment and system peripherals, record reviews, test observations, and interviews with the appropriate plant personnel.

EPA has defined three levels (see Table 1-3) to describe field audit activities and procedures and the objective of the audit.

Table 1-3:
Levels of Field Audits

Audit Level	Records Review	On-site Inspection of CEMS	Daily Calibration Observation	Linearity or RATA Observation	Performance Test Audit
Level 1	✔	✔	✔		
Level 2	✔	✔	✔	✔	
Level 3	✔	✔	✔		✔

The Level 1 audit may be used to verify Part 75 recordkeeping requirements, emissions data and monitoring plan information, and is recommended as a follow-up to a previous audit. This audit consists of an on-site inspection, records review and daily calibration observation. A Level 2 audit expands the audit to include a performance test observation. The test observation is a critical element to ensure that CEMS are properly operating and performance test protocols are being conducted in accordance with the required standards. For this reason, EPA encourages agencies to perform Level 2 audits, which are the focus of this manual.

A Level 3 audit involves agency personnel conducting a performance test instead of merely observing the test. Conducting a performance test such as a linearity test or relative accuracy test audit provides an independent assessment of the monitoring systems. Because of the equipment and expertise involved, EPA does not emphasize that State or local agencies perform Level 3 audits. However, some agencies strongly support Level 3 audit programs, and Section 8 of this document provides guidance on various Part 75-related issues for those agencies that do conduct performance tests as part of their inspection program.

1.4 Role of the Inspector

Your primary task as an inspector conducting a field audit is to document whether the monitoring at a facility is in compliance with the Part 75 requirements. To carry out this task, you will need to understand the Part 75 rule and have a general understanding of CEMS components and their function. You will also need to ask questions, carefully record your observations and compile the information necessary to determine compliance.

Your role is not to provide technical advice or consulting on the operation of the monitoring equipment. The source is responsible for operating the monitoring equipment, and correcting any monitoring problems. At the same time, however, the field audit is an opportunity to provide information to the source on Part 75 requirements. You might, for example, clarify regulatory requirements, and you should share with the source your observation of monitoring practices that may create regulatory problems.

Importance of Missing Data Under Part 75

Because Part 75 monitoring is used to account for total mass emissions, when the monitor or monitoring system fails to record a valid hour of data, Part 75 uses a conservative approach to substitute for missing data. Audit findings may invalidate data and require use of substitute data, so the findings could have a significant financial impact, independent of any non-compliance issues.

If your findings indicate that data from a monitor may be invalid, which would require the source to use substitute data, it is important to inform the source of the problem during the field audit. Extensive missing data generally will penalize a source in allowance accounting and result in a significant monetary penalty for the source. For the same reason, it is important to notify CAMD quickly of the potential for invalidating data, so that the issue is resolved prior to the end-of-year compliance process. EPA's primary concern is to collect accurate CEM data to ensure the integrity and fairness of the trading program. EPA has no interest in prolonging the length of time that a source is considered out-of-control. Thus, the goal of the audit should be to promptly identify what needs to be corrected so that the source is once again reporting quality-assured, verified emissions data. This issue is discussed further in Section 7.2.

1.4.1 "Hands Off" Approach

EPA's policy is to use a "hands off" approach when conducting the audit so that you do not have any physical contact with the CEMS hardware. This approach avoids creating a situation in which monitoring equipment may be damaged or the inspector's actions may be questioned should the monitoring system fail to operate well during the audit. You should ask authorized plant personnel to perform any actions with the CEMS equipment (for example, initiating a daily calibration check or displaying analyzer range). Remember, it is more important for you as the inspector to observe how the CEMS operator performs his/her duties, as this will indicate whether the plant personnel are able to follow appropriate requirements and procedures, and will help to identify any problems that occur. Have the operator explain what he/she is doing and show you where the procedure is documented.

1.4.2 Inspection Safety

Any type of air pollution source inspection has potential health and safety problems, and inspection safety is a serious concern. Appropriate safety training is imperative for all inspectors, and each plant may have specialized training and/or safety equipment policies. Before going on site for an audit, you must ensure that you have all necessary personal safety equipment. Also, make sure to contact the site and ask for details on plant safety requirements. Once on site, use the safety equipment properly, adhere to your agency's safety requirements, and follow plant safety requirements as well. Some of the hazards you may encounter in performing CEMS audits include:

- Accessing CEMS equipment or platforms and working at elevations with fall hazards
- Electrical shock when inspecting heated lines, pumps, or internal areas of CEMS cabinets and enclosures
- Hazards associated with use or transport of compressed gas cylinders
- Hazards associated with poisonous calibration gases (NO)
- Exposure to effluent gases
- Entry of confined spaces
- Typical hazards associated with working in an industrial environment (moving equipment, vehicles, and machinery, trip and fall hazards, etc.)

1.4.3 Recommended Training Courses

The following table lists EPA classes that you may find helpful in developing a knowledge base for performing Part 75 CEMS field audits at stationary sources. State agencies, regional organizations, or university professional development programs may provide similar courses in your area.

Air Pollution Training Institute

Information on EPA courses and course schedules are available at EPA's AIR Pollution Training Institute website: http://www.epa.gov/air/oaqps/eog/apti.html

Table 1-4:
Available EPA Training Courses

EPA Course Number	Course Title
APTI 445	Baseline Inspection Techniques
APTI 446	Inspection Safety Procedures
APTI 450	Source Sampling for Pollutants
APTI 474	Continuous Emission Monitoring
SI 476B	Continuous Emission Monitoring Systems Operation and Maintenance of Gas Monitors
T008-02	Safety and the Agency Inspector
T468-02	Stack Testing/Stack Test Observation for Traditional and Hazardous Air Pollutants

1.5 Key Part 75 Materials with Internet Links

The following is a list of key Part 75 reference materials with internet links to the webpage where the document can be found either on the EPA website or the Government Printing Office website. To avoid a dead link, the links in most cases are not to the document itself, but to the web page where a link to the document may be found. You will need to survey the page to find the direct link.

> **Recent Part 75 Revisions**
> - June 12, 2002 (67 FR 40394), and
> - August 16, 2002 (67 FR 53503)

- **40 CFR Part 75** - On the CAMD website you will find an unofficial consolidated version of the Part 72 and Part 75 rules that contains the current text of Part 75 (and §§ 72.1 - 72.3, the Acid Rain Program rule general provisions: purpose, definitions, measurements, abbreviations, and acronyms) as amended by recent revisions. You may find this unofficial version a helpful tool because it has an easy-to-use format.
  http://www.epa.gov/airmarkets/monitoring/consolidated/index.html

  While all reasonable steps have been taken to make this unofficial version accurate, the Code of Federal Regulations (CFR) and Federal Register (FR) take precedence if there are any discrepancies. Official versions of FR revisions are available on the EPA

website, http://www.epa.gov/fedrgstr/, and the official CFR is available at the Government Printing Office website.
http://www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr75_00.html

- **Electronic Data Report Version 2.2 Reporting Instructions** - The instruction manual describes each data field element for the information that is recorded and reported to EPA for Part 75, and provides the field auditor with a helpful summary of Part 75 requirements. The EDR v2.2 Instructions support the June 12, 2002 revised Part 75 rule.
  http://www.epa.gov/airmarkets/monitoring/

- **Parts 75 and 76 Policy Manual** - This manual contains a series of questions and answers that can be used on a nationwide basis to ensure that the Part 75 provisions are applied consistently for all sources affected by the rule. It is intended to be a living document. EPA will issue new questions and answers as they arise and will revise previously issued questions and answers as necessary to provide clarification. EPA intends to release a revised verison of the manual in 2003.
  http://www.epa.gov/airmarkets/monitoring/polman/index.html

- **Recertification and Diagnostic Testing Policy** - Recertification is required whenever a replacement, modification, or change in the certified continuous emissions monitoring system or continuous opacity monitoring system occurs that may significantly affect the system's ability to accurately measure or record the pollutant or parameter of interest. EPA is preparing a document to clarify what types of changes to a monitoring system may be considered significant. EPA expects that the document will describe various events as either recertification events or diagnostic testing events, and describe the type of certification or diagnostic testing that needs to be performed. You should check the www.epa.gov/airmarkets website for release of this policy.

- **Monitoring Data Checking (MDC) Software** - The MDC software, discussed in Section 3 of this manual, allows regulated industry and State agencies to enter, analyze, print, and export electronic monitoring plan, certification, and quality assurance data, and to evaluate hourly emissions data required by Part 75. The software also allows regulated sources to submit electronically monitoring plan and certification data to EPA via ftp. The software provides a standard Windows-based, mouse-driven, point and click user interface, and can be installed under Windows 95 (or higher), Windows NT, or Windows 2000. The software and installation instructions can be downloaded from the CAMD website.
  http://www.epa.gov/airmarkets/monitoring/mdc/

- **40 CFR Part 60, Appendix A Reference Methods** - The RATA reference methods (and related information) are available from EPA's Emission Measurement Center website. The website versions of the reference methods are the official CFR version.
  http://www.epa.gov/ttn/emc/promgate.html

- **An Operator's Guide to Eliminating Bias in CEM Systems** - This EPA publication is designed for CEMS operators as a tool for diagnosing and correcting the causes of measurement bias in CEMS. It is also a useful CEMS reference guide for the field auditor.
  http://www.epa.gov/airmarkets/monitoring/

- **Observer's Checklists for Test Methods 2F, 2G, and 2H** - These are detailed observer checklists that can be used when observing a flow RATA using one of these alternative flow reference methods.
  http://www.epa.gov/airmarkets/monitoring/

Section 2: Part 75 CEMS Overview

This section provides a brief introduction to the various types of components of continuous emission monitoring systems that facilities have installed to meet Part 75 requirements.

2.1 Introduction

The monitoring requirements of Part 75 are performance-based requirements that generally do not require that a source use a particular type of CEMS. There are several types of CEMS available. The differences in how these systems are designed and operate (in terms of sample acquisition, sample handling, sample analysis, and data recording) can be important in understanding what to look for in a field audit and how to interpret audit results.

This section provides only an overview of the major concepts related to the types of CEMS and their principles of operation. For further detail on these complex systems, see Section 2.7, which provides a list of in-depth references. EPA recommends that inspectors who will conduct Part 75 CEMS audits should attend EPA's Air Pollution Training Institute course on CEMS (APTI Course 474). The summary information in this section draws heavily from the manual for that course (Jahnke, 1992), as well as from an EPA reference manual specifically tailored to Part 75 CEMS (Gschwandtner and Winkler, 2001).

All CEMS perform the following basic functions:

- Locate or extract a representative sample;
- Analyze the sample; and
- Compile and record the results.

CEMS are divided into two types based on the first of these basic functions. An ***extractive system*** removes and transports the sample from the stack to the analyzer, often conditioning the sample prior to the analyzer. An ***in-situ system*** analyzes the sample directly in the stack. Illustration 2-1 identifies these two main system types. There are several variations on these types, which Sections 2.3 through 2.5 review.

Illustration 2-1:
Basic CEMS Types (Jahnke and Peeler, 1997)

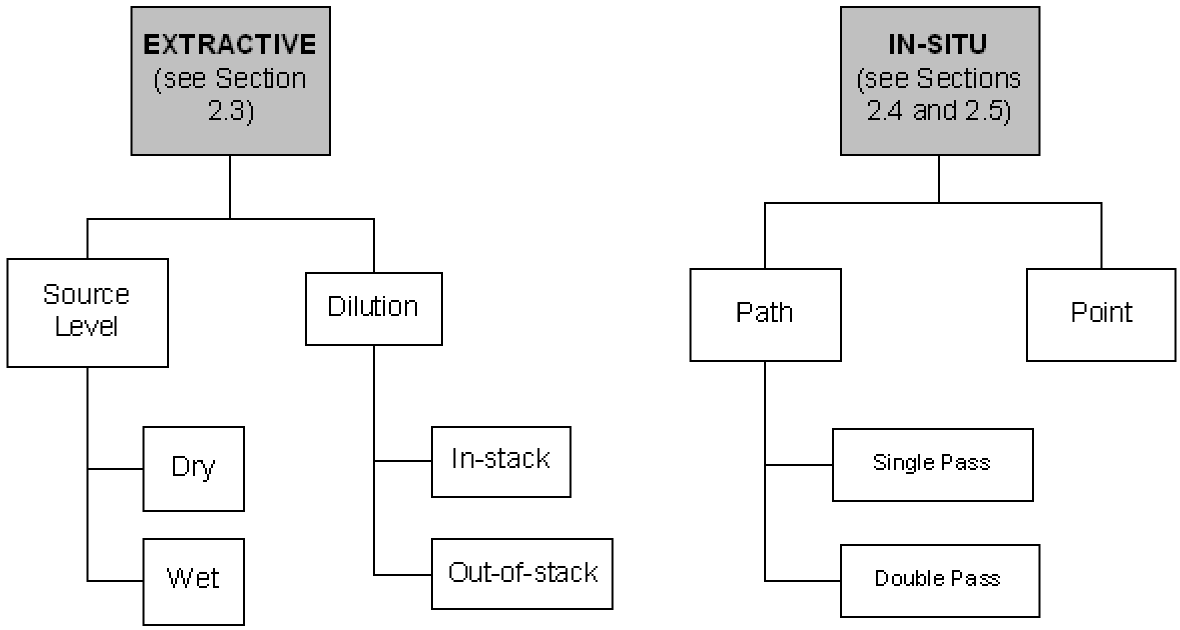
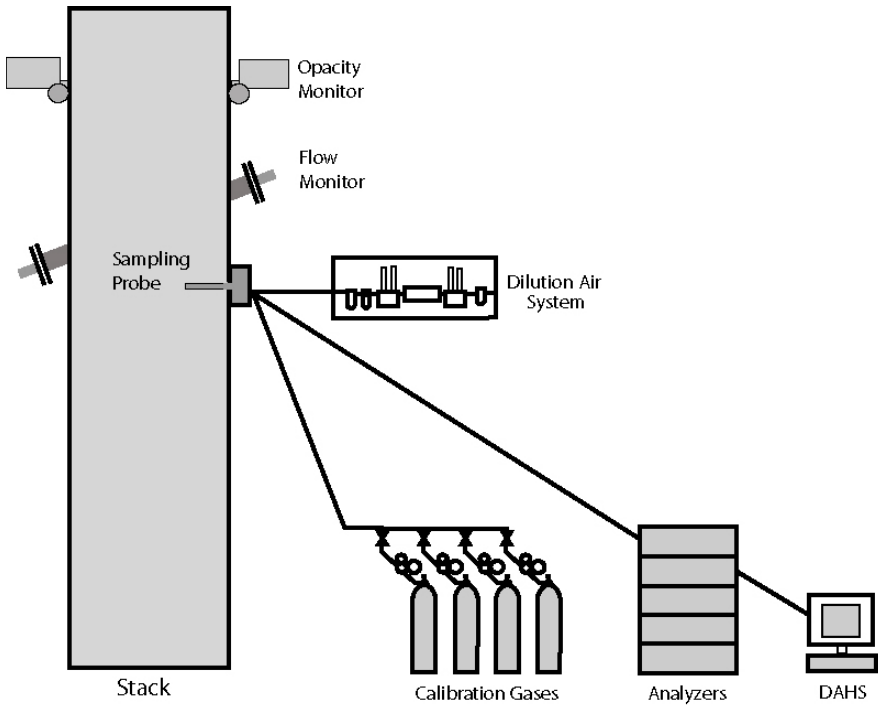


Illustration 2-2 shows a set of typical Part 75 CEMS at a Part 75 unit. The flow and opacity CEMS are examples of in-situ systems. The opacity monitor measurement is taken over a path, across the stack. Most continuous opacity monitors are double pass (light is transmitted across the stack and back to the detector) to meet EPA quality assurance requirements. The ultrasonic flow monitor in this example also provide an integrated measurement along a path across the stack. Flow and opacity CEMS are always in-situ systems. The gas CEMS (SO_2, NO_x, CO_2) in Illustration 2-2 are dilution extractive systems. In this illustration, the gas is extracted at a single point (the sampling probe) and diluted with clean dry air. The diluted sample is transported through the sampling line and analyzed on a wet basis.

Illustration 2-2:
Example of Continuous Emission Monitoring Systems at a Part 75 Unit



In-situ gas CEMS (not shown in Illustration 2-2) are also used by Part 75 sources, sometimes in conjunction with extractive gas CEMS. The use of in-situ gas CEMS for Part 75 compliance is far less common than the use of extractive systems -- in 2002 only about three percent of the gas monitors used to meet Part 75 requirements were in-situ monitors. In-situ gas CEMS can measure at a point (or short path) like an extractive gas CEMS or along a path across the stack similar to an opacity monitor.

The following sections begin with a discussion of Part 75 requirements for the sample measurement location, and then briefly describe the three basic types of systems under Part 75 (gas extractive CEMS, gas in-situ CEMS, and Flow CEMS). The final CEMS component -- the data acquisition and handling system (DAHS) used for electronic data and reporting -- is a critical element for Part 75 compliance and is discussed separately in Section 2.6. Finally, Section 2.7 provides references that you can use to gain an in-depth understanding of how these systems operate and what their limitations are.

2.2 Sampling Location

Whether the system is extractive or in-situ, the flue gas must be monitored at a location where the pollutant concentration and emission rate measurements are directly representative of the total emissions from the affected unit. Flowing gases are generally well mixed, but in some cases gas stratification can be a concern for the gas measurement location. Stack flow, on the other hand, is always stratified to some degree (lower velocities along the stack walls). Cyclonic or swirling flow (flow that is not parallel to the stack center line) also will have a negative impact on flow monitors and manual reference test methods. Thus, the selection of sampling points and paths is an important concern for flow monitors. To obtain a representative measurement, and avoid problems due to stratification and cyclonic flow, Part 75 provides specific requirements for the CEMS sampling location in Appendix A, § 1.

2.2.1 Gas Measurement Location

Part 75 requires that the representative sampling location be chosen based on the procedures in 40 CFR Part 60, Appendix B, Performance Specification 2, which suggests a measurement location: (1) at least two equivalent diameters downstream from the nearest control device, the point of pollutant generation, or at another point at which a change in pollutant concentration or rate may occur, and (2) at least a half equivalent diameter upstream from the effluent exhaust or control device. Other Part 75 location requirements from Appendix A are summarized below:

- Locate the measurement location so that the gas CEMS (pollutant and diluent monitor) passes the certification RATA. (Note - while not required specifically, the diluent O_2 or CO_2 monitor should sample at the same point as the pollutant monitor.)

- Point Monitors - Locate the measurement point (1) within the centroidal area of the stack or duct cross section, or (2) no less than 1.0 meter from the stack or duct wall.

- Path Monitors - Locate the measurement path (1) totally within the inner area bounded by a line 1.0 meter from the stack or duct wall, or (2) such that at least 70.0 percent of the path is within the inner 50.0 percent of the stack or duct cross-sectional area, or (3) such that the path is centrally located within any part of the centroidal area.

2.2.2 Flow Measurement Location

Part 75 establishes the following basic location criteria for flow monitors:

- The location satisfies the minimum siting criteria of Part 60, Appendix A, Method 1 (i.e., the location is greater than or equal to eight stack or duct diameters downstream and two diameters upstream from a flow disturbance, or, if necessary, two stack or duct diameters downstream and one-half stack or duct diameter upstream from a flow disturbance); or

- The results of a flow profile study, if performed, are acceptable (i.e., there are no cyclonic (or swirling) or unacceptable stratified flow conditions). Part 75 recommends that if a flow profile study indicates unacceptable results, the facility should relocate the monitor or add straightening vanes or other source modifications to correct the flow patterns.

Regardless of whether these criteria are met, a flow monitor can be installed in any location if the flow CEMS can meet the Part 75 performance specification requirements.

2.2.3 Sampling in Stratified and Swirling Flow Conditions

Stack flow is seldom ideal, and some degree of stratification and swirling flow will be present at the monitoring location. Approaches to dealing with stratification, swirling or cyclonic flow, and changing flow profiles due to load changes are discussed below.

- *Stratified Flow* - Flow monitoring systems may locate a single point or path representative of the reference method determined stack flow if the stratification is fairly constant over varying loads. If stratification varies with load, an array of sampling points can be placed across the stack to obtain a flow average instead of one single sample point. For a path monitoring system that is already averaging over a line across the stack, the source can select a path that is not as sensitive to the variation or can add a monitor to provide multiple paths on the cross section.

- *Correction Factors* - Part 75 allows the source to calibrate the flow monitor to the reference method flow (pre-RATA). Sources commonly use this approach to enable a flow CEMS to pass the multi-load flow RATA at a particular measurement location. A flow RATA typically is performed at three loads to account for different flow profiles at changing loads. The options described above for stratified flow can include application of a correction factor for stratification based on the reference method RATA values. If the source conducts a test using new Methods 2F, 2G, or 2H (developed to account for non-parallel flow conditions and wall effects on flow measurement), calibrating to the reference method also can account for effects due to swirling. Method 2 using the s-type pitot tube will be subject to bias if swirling or stratification due to wall effects or other factors are present. Calibration of flow monitors relative to Method 2 under such conditions will not account for those effects.

2.3 Extractive Gas CEMS

There are two types of extractive gas CEMS:

- The *"source level" or "direct extractive"* system extracts gas from the stack, and conveys the sample to one or more analyzers. These extractive systems will include filters to remove particulates and may include conditioning to remove moisture, acids, condensible particulates, and interfering compounds. In the case of a hot wet system, the sample lines and analytic components of the systems are heated to prevent condensation of the stack moisture. Heated lines are also required for dry systems up to the point where conditioning occurs.

- A *dilution extractive system* filters the stack sample and dilutes the stack sample with clean dry air. Dilution occurs either inside the sample probe in the stack or outside of the stack, usually at the stack port. Dilution systems sample the gas at flow rates much smaller than those used in source level systems. Using dry air to dilute the flue gas at ratios of 50:1 to 300:1, the dew point of the diluted sample is reduced to levels where condensation will not occur in the monitoring system. As a result, moisture removal systems and heated sample lines may not be incorporated into the system. A dilution air cleaning system, however, is required to clean the dilution air and remove CO_2, water, and any traces of the gases that are to be monitored.

2.3.1 Source Level or Direct Extractive Systems

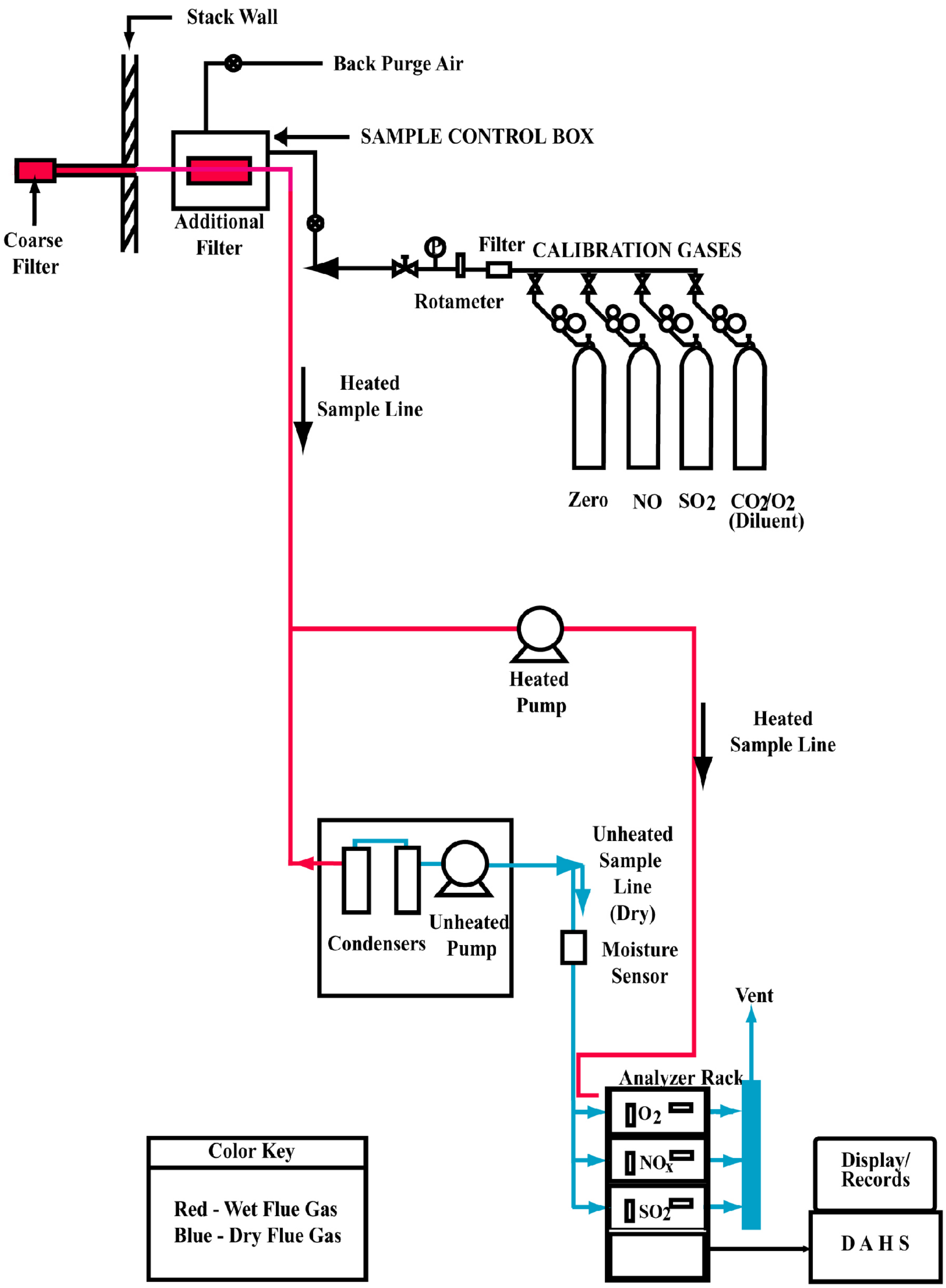
A diagram of a source level extractive system is shown in Illustration 2-3. The illustration shows both wet (heated sampling line by-passing the conditioning system) and dry systems.

2.3.1.1 Sample Probe

Probes for source level extractive systems are constructed with stainless steel or Hastelloy® tubes. A coarse filter is commonly attached at the end of the probe to filter out particulate matter before it can enter into the tube. Some designs place a deflector plate or cylindrical sheath around the filter to provide protection from plugging. A coarse filter can also be in-line in a housing outside of the stack prior to the sample line. Sometimes a combination of filters, a coarse filter at the probe opening, and an in-line fine filter outside of the stack, are used to ensure the removal of particulate matter.

Blowback or back purging is frequently used to keep the coarse filter from plugging. This involves blowing pressurized air or steam back through the filter in an opposite direction to the normal stack flow. The blowback occurs at regular intervals (typically from 15 minutes to 8 hours) and typically lasts for 5 to 10 seconds.

Illustration 2-3:
Typical Source Level Extractive CEMS
(Gschwandtner and Winkler, 2001)



2.3.1.2 Sample Transport and Conditioning Systems

Most source level extractive systems used in Part 75 applications are dry systems which remove moisture prior to the sample pump and analyzer. In a dry system the sample line from the probe to the moisture removal system is heated to prevent water condensation. If the facility uses a wet system that does not remove moisture prior to the analyzer, the entire length of the sample line, sample pump, and analyzer must be heated. The sample line is usually wrapped in a tube bundle or umbilical which includes the sample lines, blowback lines, calibration gas lines, heating elements, and electric lines.

Dry source level CEMS used in conjunction with a flow CEMS for Part 75 SO_2, NO_x and CO_2 mass measurements must also determine the moisture content of the stack gas. Illustration 2-3 shows a heated "wet" sample line connected to a wet O_2 analyzer. This wet system is used in conjunction with the dry system's dry O_2 analyzer to determine moisture. Another alternative is to use an in-situ "wet" O_2 analyzer with the dry extractive O_2 analyzer. A less common approach is to use an H_2O analyzer to measure the wet sample.

Moisture Removal Systems

There are two common types of moisture removal systems: condensers and permeation dryers. Condensers cool the gas below the dew point (using refrigerated coils or cooled jet stream condensers), and then remove the condensed liquid water from the gas stream. Water removal is performed automatically to prevent filling the condensate trap and flooding the sampling line. Absorption of SO_2 and NO_2 in the condensate is a concern, so systems are designed to minimize contact time between the dried gas and liquid.

Permeation dryers are constructed using Nafion®, a material that selectively allows the mass transfer of water vapor from the sample gas through the tube membrane to dry purge gas flowing in an outer tube in the opposite direction. The gas entering the permeation dryer must be heated above the dew point temperature. Permeation dryers avoid the problems of condensate absorption of pollutants and do not have condensate traps. However, the dryers can be subject to plugging problems from condensing liquids, particulates, or precipitates.

Pumps

Diaphragm pumps and ejector pumps are the most common pumps used in extractive systems. Both operate without pump lubricating oils, which can cause sample contamination. Both diaphragm pumps and ejector pumps can be heated and used in a hot wet system, or used ahead of a conditioning system.

Fine filter

Many analyzers require removal of particulate larger than 0.5 µm, so systems will usually have an additional fine filter near the analyzer inlet. There are two types: (1) a surface filter, usually paper or other porous material which builds up a filter cake, and (2) a depth filter, which consists of packed fibers of quartz wool or other material.

2.3.2 Dilution Extractive Systems

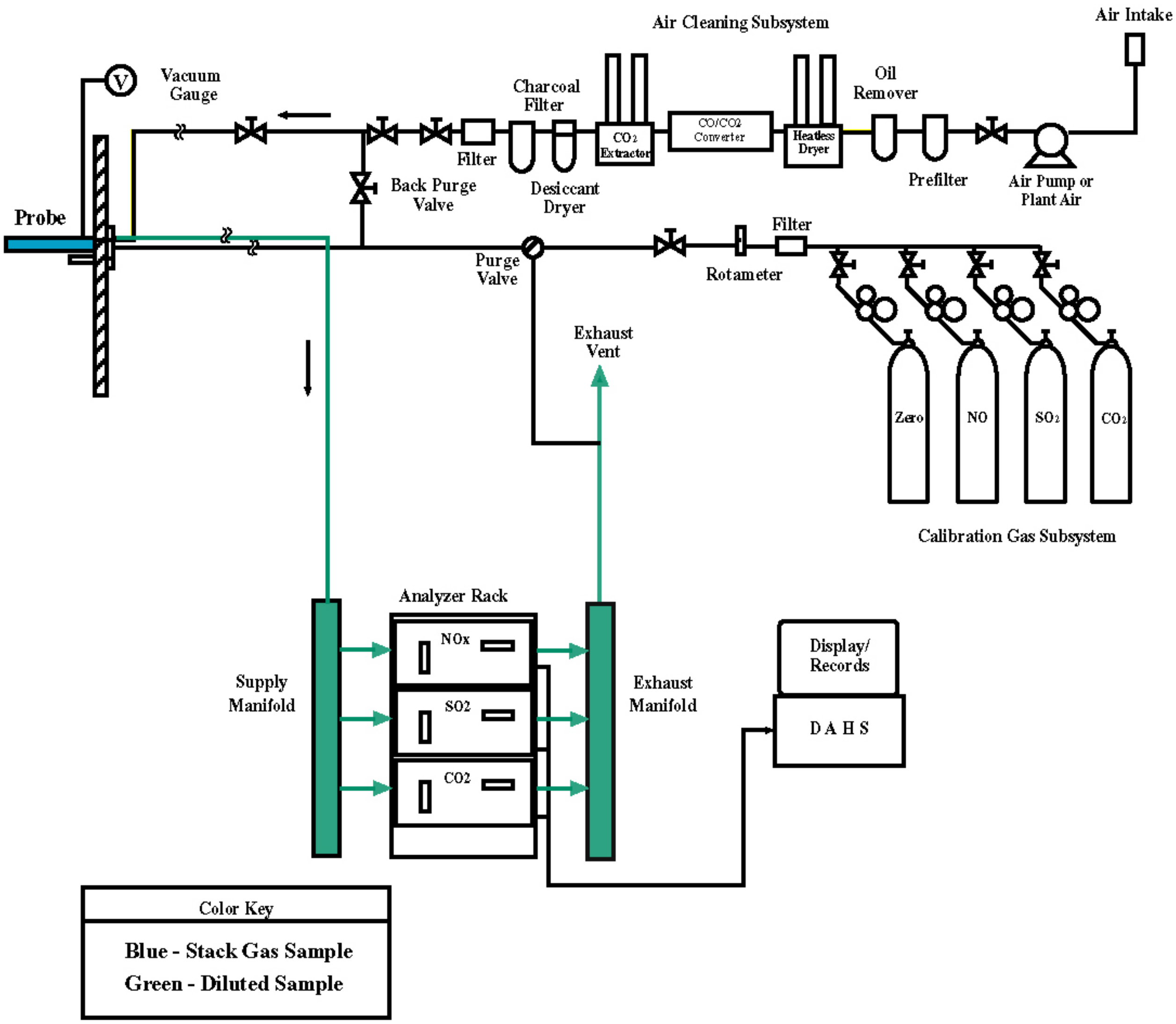
Dilution Ratio = $\frac{Q_1 + Q_2}{Q_2}$

where:

Q_1 = dilution air flow rate (L/min)
Q_2 = sample flow rate (L/min)

Most coal-fired units subject to Part 75 use dilution extractive systems. As noted earlier dilution ratios range from 50:1 to 300:1. A diagram of a dilution extractive CEMS is provided below showing an in-stack dilution probe, unheated sample lines and pumps, air cleaning subsystem, calibration gases, analyzers, and DAHS.

Illustration 2-4:
Dilution Extractive CEMS
(Gschwandtner and Winkler, 2001)

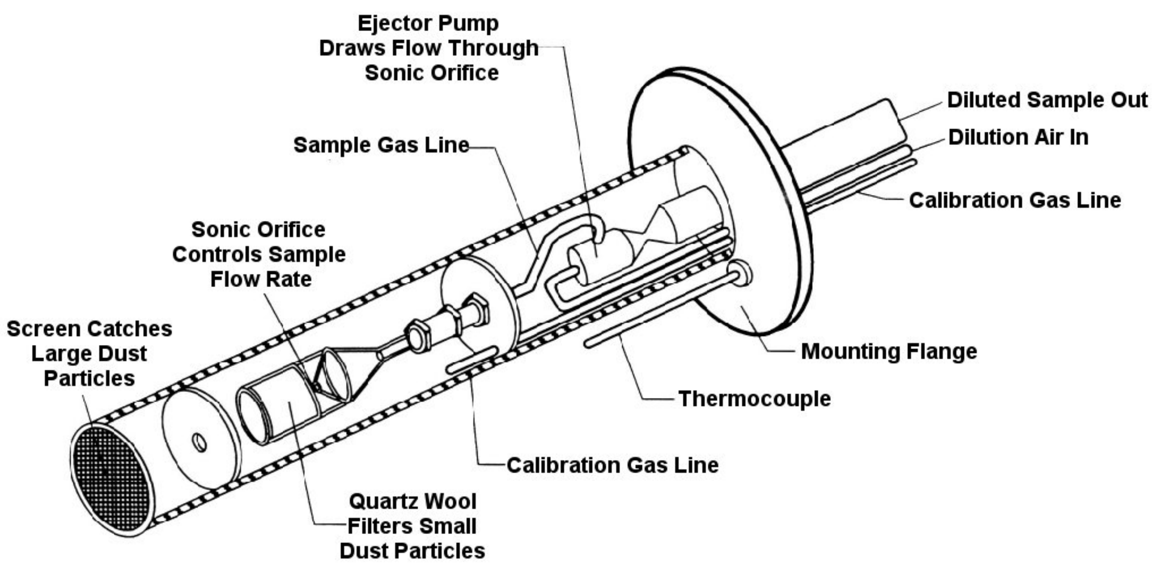


The dilution of the sample can occur in the stack using a dilution probe, or outside the stack using an out-of-stack dilution system. Both approaches use the same operating principles. A critical orifice controls the sample gas flow rate, which is drawn through the orifice by creating a vacuum at the outlet of the orifice with an ejector pump. As long as a sufficient vacuum is present, the sample gas flow rate through the critical orifice is independent of the downstream pressure. The ejector pump, also called an aspirator or an eductor pump, is operated by the compressed, dry, clean dilution air. The dilution air flow through the venturi nozzle of the pump (flow rates of 1 to 10 L/min) creates the vacuum pressure at the orifice outlet. This vacuum pulls the gas sample through the orifice at rates of 50 to 500 mL/min (limited by the orifice design), and into the ejector pump where it mixes with the dilution air.

2.3.2.1 Dilution Probe

The in-stack dilution probe combines a sonic orifice (a glass tube drawn to a point) with an ejector pump inside the stack probe. (See Illustration 2-5.) The probe opening inside the stack is screened and uses a quartz wool filter to prevent particulate matter from entering the orifice. Plugging has been a problem in applications with wet saturated conditions (after a wet scrubber) due to condensation that causes wetting of the filter and plugging of the orifice. In some cases, heated dilution probes have been successfully used where entrained water droplets are present.

Illustration 2-5:
In-Stack Dilution Probe (adapted from Jahnke, 2000)



Gas Density Affects

The sonic flow of stack gas through the orifice is affected by the stack gas density and viscosity, which in turn are dependent on molecular weight, stack pressure, and temperature. A change in any of these factors will affect the sonic flow and dilution ratio. The primary means for addressing theses issues include:

- Molecular Weight Effect - Gas density changes that result from changing molecular weight are mainly due to changes in-stack moisture or CO_2 concentrations. These parameters do not vary much in base load units, but both can be monitored and often are as part of the Part 75 CEMS. With these measurements, empirical corrections can be made to the dilution ratio.

  The molecular weight effect is also a concern in choosing calibration gases. Gases used in the initial and subsequent QA tests should have a consistent molecular weight, otherwise a bias can be introduced due to the molecular weight differences.

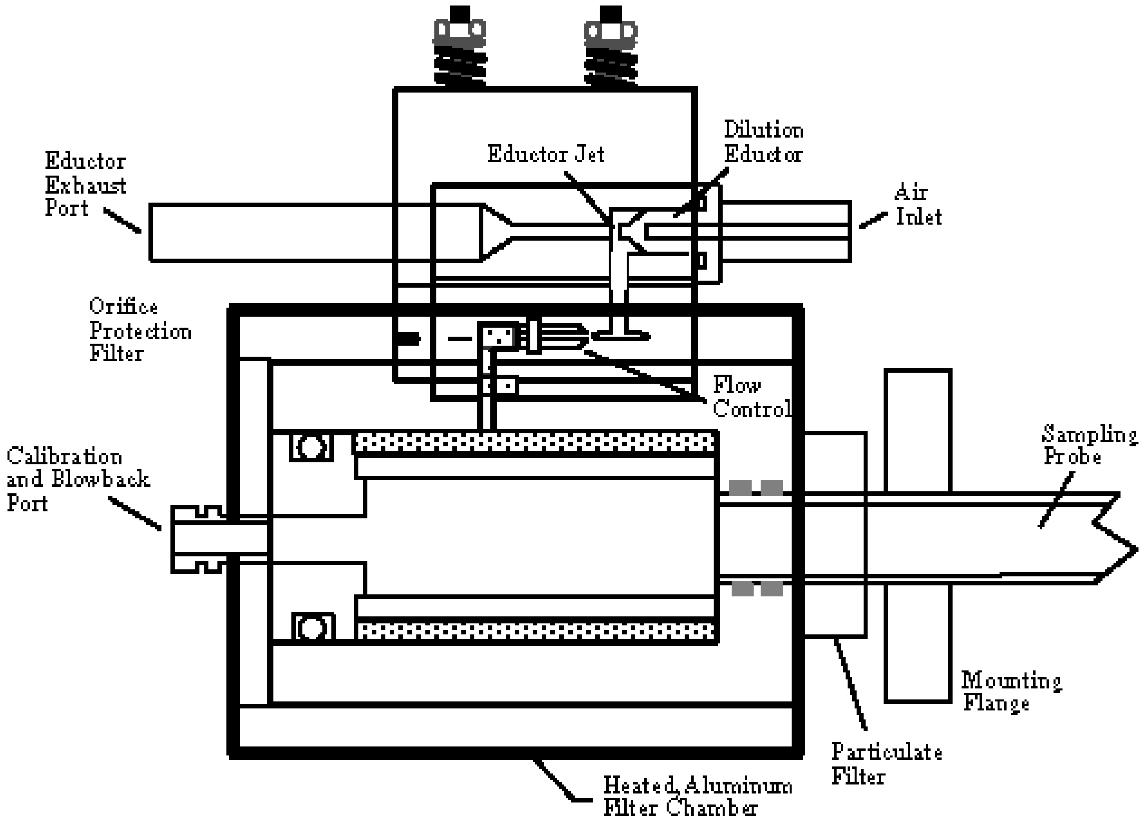
- Stack Pressure - Stack pressure (absolute stack pressure which includes ambient pressure and stack static pressure) can vary due to changing load or ambient conditions. Stack pressure can be monitored separately, with the DAHS applying pressure related correction algorithms to the CEMS data.

- Temperature - Temperature also can vary with load and can be monitored separately with the DAHS correcting the data, as described above. Temperature correction factors have been more difficult to develop, however, and have not worked well in situations with temperature changes greater than 50ºF. (Note - Calibration checks performed when the source is not operating may not provide valid results due to the temperature effect). In response, some vendors heat the dilution probe -- the heated probe is the same as shown in Illustration 2-5, except electric heating coils are placed around the probe and controlled to maintain a constant temperature. Another approach for stabilizing the temperature is to use an out-of-stack dilution system, described in the next section.

2.3.2.2 Out-of-Stack Dilution System

The out-of-stack dilution system dilutes the sample outside of the stack where it is easier to maintain a constant temperature. As noted earlier, dilution in out-of-stack dilution systems is performed in the same manner as with in-stack dilution probes, this time with a critical orifice and ejector pump. Illustration 2-6 diagrams one manufacturer's out-of-stack dilution system. The probe in this type of system is a simple tube similar to that used in a source level system. Note that these systems are also affected by the changes in gas density described above, and the use of stack moisture or CO_2 corrections may be necessary.

Illustration 2-6:
One Type of Out-of-Stack Dilution System
(Gschwandtner and Winkler, 2001)



2.3.2.3 Sample Transport and Dilution Air Cleaning Systems

Sample Lines

The sample line for a dilution system, as in the source extractive system, is often wrapped in a tube bundle or umbilical which includes the sample lines, blowback lines, calibration gas lines, heating elements, and electric lines. The sampling line often does not need to be heated after the dilution air has been added, but heated "freeze protect" lines are used in regions of the country where sub-zero temperatures may occur, or if the dilution ratio is low.

Dilution Air Cleaning System

The dilution air cleaning subsystem delivers dry, clean, pollutant-free air to the dilution probe. It consists of a series of particulate and charcoal filters, dryers, and scrubbers, which reduce CO_2, NO_x, SO_2, moisture, organic compounds, and other compounds in ambient air to sub-ppm levels.

The dilution air is compressed air provided by the plant's utilities, commonly referred to as "plant air," or from a compressor dedicated to the CEMS. In either case the compressed air enters an air cleaning subsystem where it is further cleaned and regulated. If the filters and scrubbers are changed regularly, and there are no leaks in the subsystem, the dilution air will be dry, clean, and free of contaminants, including CO_2.

The flow of pressurized dilution air through the ejector pump moves the sample to the analyzers, so a separate pump is not required. The dilution air pressure should be held relatively constant because changes in the pressure will affect the dilution ratio. Some systems include mass flow controllers to maintain the dilution flow rate at a constant level.

2.3.3 Calibration Gas System

Part 75 quality assurance requirements include daily calibration error tests and linearity tests (usually quarterly), which challenge the extractive gas CEMS with calibration gases of known concentrations. The calibration gases used in the tests include a zero level gas, as well as low, mid, and high concentration levels based on the span of the monitor. The calibration gas system consists of calibration gases, gas regulators, valves, and line filters. The gases must meet the criteria specified in Part 75, Appendix A, § 5.1.

Calibration gases for the daily calibration error test and linearity tests are injected as close as possible to the probe (Part 75, App. A, § 2.2.1). The calibration gas system must include controls to ensure that calibration gases are injected at the same flow rate, pressure, and temperature as the sample gas under normal system operation.

There are two common injection locations for source level extractive systems: (1) the calibration gas is injected into the in-stack probe external filter housing and is drawn into the sampling system, or (2) the calibration gas may be injected into an internal filter housing between the probe and sample line at the stack flange. In dilution extractive systems, the calibration gas must be injected into the dilution probe housing, with the calibration gas drawn through the sonic orifice. In an out-of-stack dilution system, the calibration is injected prior to the inlet of the critical orifice.

Calibration gases are also sometimes injected at the analyzers when performing certain diagnostic tests or calibration adjustments.

2.3.4 Analyzers

Gas analysis methods for extractive systems can be divided into four major categories. Those categories, with common Part 75 applications, are shown in Table 2-1 and are briefly described below. More detailed discussion of analyzer operating principles are available in the references listed in Section 2.7. The CEMS designer will choose the analytical method based on the overall system design (e.g., dilution extractive versus source-level extractive, wet versus dry systems). In source level extractive systems, the gas analyzers measure at stack concentrations in the ppm range, while in the dilution extractive system gas analyzers read in the ppm or ppb range similar to those of ambient monitors.

Table 2-1:
Common Extractive Gas CEM Analytical Methods

Techniques	Gas Measured
Absorption Spectroscopic Methods	
Non-Dispersive Infrared (NDIR)	SO_2, NO, CO_2, H_2O
Gas Filter Cell Correlation (GFCIR)	SO_2, NO, CO_2, H_2O
Differential Absorption (UV) or (IR)	SO_2, NO, CO_2
Luminescence Spectroscopic Methods	
Chemiluminescence	NO, NO_x
Fluorescence	SO_2
Electro-Analytical Methods	
Electrocatalysis	O_2
Paramagnetic Techniques	
Magnetodynamic	O_2
Thermomagnetic	O_2

2.3.4.1 Absorption Spectroscopy

Absorption spectroscopic methods measure the amount of light absorbed by a pollutant molecule. The analyzer has four main components: (1) radiation source to produce the light in the desired range of the spectrum, (2) spectral limiters which further reduce the band width of the light to specific wave lengths, (3) detectors which measure the light energy, (4) optical components which direct and focus the light, and (5) components to correct for interfering gases and drift (e.g., a reference gas cell).

Non-Dispersive Infrared (NDIR)

Non-Dispersive Infrared (NDIR) monitors are commonly used to measure CO_2 in dilution extractive systems. The analyzer measures the degree of absorption of infrared light by molecules in the sample gas compared to a reference cell containing gas that does not absorb infrared light in the wavelengths used by the instrument. The ratio of the detector signals from the two cells is used to determine the light transmittance which is related to the CO_2 concentration using calibration curves developed with known gas quantities. The monitors are called non-dispersive because filters are used to narrow (not disperse) the infrared wavelength to a small range centered on the absorption peak of the molecule of interest.

Gas Filter Cell Correlation (GFCIR)

Gas Filter Cell Infrared analyzers use a variation of the NDIR technique by using a reference cell that contains 100 percent concentration of the pollutant measured instead of 0 percent. The reference cell will remove most of the light at the infrared wavelength absorbed by the compound of interest. This method is more commonly used in in-situ applications, but is used in extractive systems.

Differential Absorption

Differential Absorption analyzers perform measurements at two different light frequencies. One frequency is absorbed by the target molecule, while the other reference frequency is not. The ratio of the absorption at the two wavelengths is correlated to the target gas concentration. Again, calibration curves are created using known gas concentrations. Part 75 sources use UV non-dispersive photometers for SO_2 and NO_x measurements. These types of instruments can be used in wet extractive systems, as water vapor does not absorb light very well in the UV region. There are also differential absorption analyzers that use light in the infrared region, particularly for CO_2 in wet source-level extractive systems.

A single differential absorption analyzer may also measure a number of component gases by using multiple wavelengths of light.

2.3.4.2 Luminescence Spectroscopy

Luminescence spectroscopic methods measure the amount of light emitted by an excited molecule. Analyzers using these methods are very specific for a given molecule and are more sensitive than absorption spectroscopy or electrochemical methods. As in the absorption spectroscopic methods, all of the instruments use calibration curves developed from known target gas compositions to relate the measured light energy to gas concentration.

Chemiluminescence

Chemiluminescence monitors are commonly used for NO_x in dilution extractive systems. Chemiluminescence is the emission of light produced as a result of a chemical reaction, and a chemiluminescence NO - NO_x monitor measures the amount of light generated by the reaction of NO with O_3. This monitor uses an ozone generator to produce O_3, and a catalytic converter to reduce NO_2 in the sample gas to NO before reacting with O_3. The monitor can measure both NO or NO_x by sequencing the NO-O_3 reactions. First, the sample gas can bypass the converter and go directly to the reaction cell, measuring the NO. Then, after this reaction, the gas goes to the converter where the NO_2 is reduced to NO and sent back to the reaction chamber to measure NO_x (NO and NO_2). NO_2 can be determined by subtracting the NO measured by the first measurement from the total NO_x (NO and NO_2) measured in the second step.

Fluorescence

Fluorescence analyzers are used to measure SO_2 in both dilution and source-level extractive systems. Fluorescence occurs when a molecule absorbs light at one wavelength; as a result of the absorbed energy, the molecule emits light at a different wavelength. The analyzer uses light (either from a continuous or pulsed infrared light source) to irradiate the gas sample. The light radiated back from the sample is measured by the sensor, after filtering to select a narrow bandwidth of the fluorescent radiation.

Interference from quenching is a concern for both chemiluminescence and fluorescence analyzers. Quenching occurs when the excited molecules collide with other molecules, losing energy as a result of the collision. This changes the energy state from the level caused by the analyzer chemical reaction or irradiation. For example, in a fluorescence analyzer the excited SO_2 molecule in the gas sample might collide with another molecule, changing its energy state from what it would have been due to the analyzer irradiation. This can be a problem if the stack gas composition changes, as different molecules have different quenching affects. It is also a problem if the calibration gas background concentrations change (single blend - multiblend calibration gases).

Quenching effects can be limited by using dilution extractive systems, which will result in a constant background composition (the dilution air). Fluorescence analyzers can also use ultraviolet light at lower wavelengths to shorten the fluorescence time to reduce quenching probabilities. Chemiluminescence systems can increase the O_3 flow into the reaction chamber to provide a more constant background concentration.

2.3.4.3 Electro-Analytical Methods

The zirconium oxide (ZrO_2) analyzer, an electrocatalytic analyzer, is the most common O_2 analyzer used by Part 75 sources. The analyzer can measure O_2 on both a dry and wet basis, and it is used with source level extractive systems and as an in-situ monitor.

This analyzer uses a heated ceramic material (ZrO_2) with a thin platinum catalytic coating as a solid electrolyte which allows the transfer of oxygen from the reference side of the cell (maintained at 21 percent O_2) to the sample side (continual flow of stack gas with lower O_2 concentrations, e.g., 3 - 6 percent). The sample O_2 concentration can be determined by measuring the electromotive force of the O_2 transfer, combined with a stable cell temperature and reference cell partial O_2 pressure.

The ZrO_2 electrolyte is heated to 850 ºC. At that temperature O^{-2} ions catalyzed by the platinum can move through the material. Combustibles materials in the stack gas sample (CO, hydrocarbons), can burn at the operating temperatures of the analyzer consuming sample gas O_2. The combustible concentrations, however, are in much lower concentrations (ppm) than the O_2, and have a negligible impact on O_2 measured on a percentage basis.

2.3.4.4 Paramagnetic Techniques

Paramagnetic techniques are also used by Part 75 sources to measure $O_{2.}$ Analyzers using these techniques are only used in conjunction with source level extractive systems, and water and particulate matter must be removed prior to the monitor.

Molecules that are attracted by a magnetic field are described as paramagnetic, while those repelled are called diamagnetic. Most materials are diamagnetic, but O_2 is paramagnetic and strongly attracted to magnetic fields compared to most other gases (though NO and NO_2 are also paramagnetic and may cause interference if present at high concentrations).

Magnetodynamic

A magnetodynamic analyzer makes use of the effect that O_2 has on modifying a magnet's magnetic field. In a "dumbbell type" of magnetodynamic analyzer, a torsion balance dumbbell with diamagnetic glass spheres is suspended in a nonuniform magnetic field. The dumbbell spheres are pushed away from the strongest part of the magnetic field. Oxygen alters the field causing a change in the dumbbell position. A light source, mirror on the dumbbell, and detector measure the dumbbell position. Current through a wire encircling the dumbbell creates an electromagnetic counter-torque which restores the mirror to the position when O_2 is not present. The amount of current required to restore the dumbbell position is related to the amount of O_2 present.

Thermomagnetic

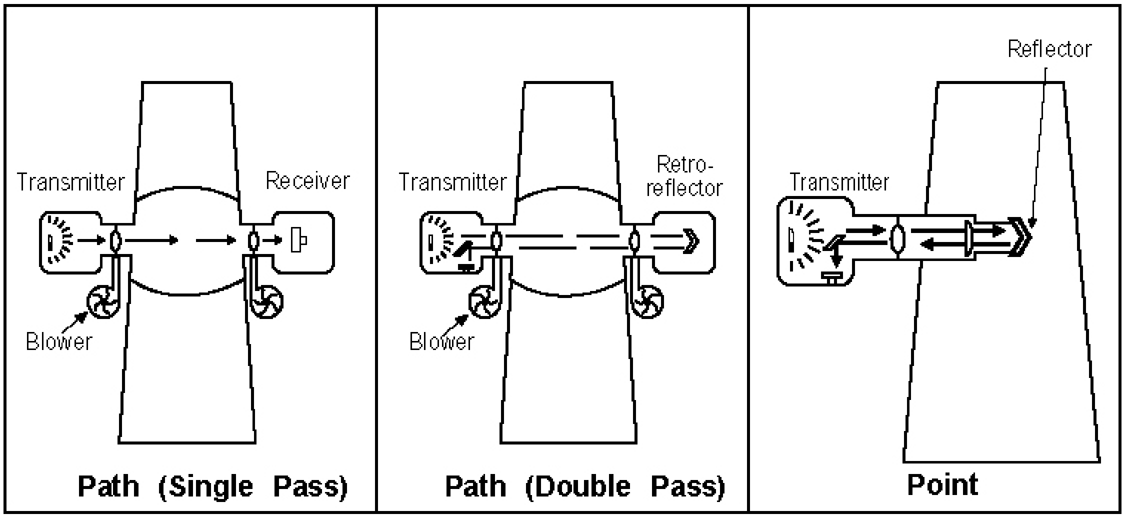
Thermomagnetic analyzers are often called "magnetic wind" analyzers, and are based on the decrease in the paramagnetic attraction of O_2 with increased temperature. The O_2 in the sample gas is drawn into a tube with a heated coil filament and magnetic field at one end. The O_2 enters the tube attracted by the magnetic field. As the molecules are heated the paramagnetic attraction is decreased, and the heated molecules are pushed out by cooler molecules with stronger paramagnetic attraction. The O_2 flow through the tube creates the so called "wind," and cools the heating coil reducing its resistance. The change in resistance is measured and related to O_2 concentration. The monitor can be affected by changes in the gas composition which affect thermal conductivity and the filament temperature. Combustible materials can also react on the heated filament changing the resistance.

2.4 In-Situ Gas Monitors

In-situ gas monitors are far less common at Part 75 sources. In-situ monitors were initially designed for high concentration combustion gas applications, not for the lower pollutant gas concentrations following pollution control devices. Some in-situ analyzers also had difficulty meeting EPA certification and quality assurance requirements. However, in-situ monitors do have some advantages over extractive systems. The monitoring system measures concentrations at stack conditions and eliminates the need for the sample transport and conditioning systems required by extractive CEMS. Newer designs offer a wider range of analyzer options, and virtually all point and some path systems can now be calibrated with calibration gases as required by Part 75.

In-situ monitors are classified as either path or point monitoring systems. (See Illustration 2-6.) The in-situ point CEMS measures gas concentrations at a single point in the stack, much like the single probe in a gas extractive system. The term "point" is used when the sampling is over a short path, but still much less than the stack cross-section. The in-situ path CEMS measures gas concentrations over an optical path equivalent to the internal stack diameter by transmitting a light through the flue gas (single pass) and sometimes back (double pass).

Illustration 2-7:
In-Situ Gas CEMS (Jahnke, 1992)



2.4.1 Path In-Situ CEMS

Path in-situ CEMS use spectroscopic analytical methods to measure pollutant concentrations in the flue gas. The systems have the same principle components as an absorption spectroscopic analyzer described in Section 2.3.4.1: (1) radiation source to produce the light in the desired range of the spectrum, (2) spectral limiters which further reduce the band width of the light to specific wave lengths, (3) detectors which measure the light energy, and (4) optical components which direct and focus the light. In addition, blowers are required to keep the optics clean of stack particulate.

In a single pass system, a light transmitter and detector are located on opposite ends of the light path, and the light makes one "pass" along the measurement path. A double pass system has the transmitter and light source on one end of the sample path and a retroreflector at the opposite end to reflect the light back to the detector. The light makes two "passes" along the measurement path.

2.4.2 Point In-Situ CEMS

The in-situ point CEMS typically consists of a measurement probe which contains a cavity in which the sample gas can be measured either by a sensor or by light absorption. The probe opening is protected by some sort of particulate filter (ceramic, sintered stainless steel, or Hastelloy® filter). The sample concentrations within the cavity adjust to changing effluent concentration via diffusion through the filter.

2.4.3 In-Situ Gas Analyzers

In-situ monitors use spectroscopic and electro-analytical techniques similar to extractive systems described earlier in Section 2.3.4. In extractive system spectroscopic analyzers, the light interacts with the sample within the analyzer instrument. For in-situ spectroscopic analyzers, the light interacts with the sample in the sample probe (point in-situ) or across the stack diameter (path). Analytical methods used by in-situ gas monitors at Part 75 sources are shown below in Table 2-2.

Table 2-2:
In-Situ Gas Analyzer Methods

Techniques	Gas Measured
Absorption Spectroscopic Methods	
Differential Absorption (UV)	SO_2, NO
Gas Filter Cell Correlation (GFCIR)	CO_2,
Second Derivative Spectroscopy (UV)	SO_2, NO
Electro-Analytical Methods	
Electrocatalysis	O_2

2.4.4 System Calibration

Daily calibration error tests and linearity tests can be performed on point in-situ gas CEMS in a manner similar to extractive gas CEMS, by flooding the probe with the calibration gases. QA tests for path systems are more difficult. Path systems can use a flow through calibration cell that is placed in the measurement path for linearity and calibration error tests. The tests must use EPA Protocol gases, and the calibration cell must be located so as to challenge the entire measurement system.

The system consists of a calibration cell, which is a flow-through gas cell for the zero and other calibration gases, and a zero mirror to reflect the light back to the detector without traveling through the stack. The calibration cell should be at the same temperature and pressure as stack conditions. If the flow-through cell has a length shorter than that of the sample path, calibration gas at high concentrations (percent levels) may be necessary. For CO_2, the only way to perform the daily calibration and linearity tests is to have a flow-through cell with the same path length as the sample path.

A single path system can not use a zero mirror. One approach for single pass systems is to use a zero pipe combined with the flow through calibration cell. The zero pipe provides an optical path not affected by the stack gas.

2.5 Flow CEMS

There are three types of flow CEMS in use today at Part 75 sources:

- Differential pressure flow monitors,
- Thermal mass flow monitors, and
- Ultrasonic flow monitors

All of the flow monitors are in-situ monitors, determining flow on a wet basis based on dynamic measurements of parameters that can be related to the stack velocity at a point or along a path within the stack.

2.5.1 Sampling Location

As noted earlier in Section 2.2, the measurement location must provide a representative volumetric flow over all operating conditions. Stratified flow profiles, cyclonic flow, and flow profiles that change with load all can impact the choice of measurement location. Multiple measurement points or paths and the use of correction factors to calibrate the flow CEMS to the reference method (pre-RATA) may be required to meet the location requirements in Appendix A, § 1.2.

Factors Affecting Flow Data Accuracy

- Representative sampling points
- Sensor/monitor accuracy and stability (performance specifications in Appendix A, § 3.3)
- Accuracy of secondary parameter values (gas temperature, measurement path length)
- Accurate duct dimensions (area calculation)
- Proper calibration

2.5.2 Differential Pressure Flow Monitors

Differential pressure monitors sense the difference between the impact and wake pressures at tube openings (pitot tubes or multi-point tubes) in the gas flow, and a differential pressure transducer converts the pressure signals into electric current. The differential pressure is the difference between the impact and wake pressures. The differential pressure is combined with stack gas temperature, stack pressure, and molecular weight to determine velocity using the pitot equation below. Volumetric flow is calculated by multiplying velocity by the stack or duct cross sectional area.

$$v_s = K_p C_p \sqrt{\Delta p_{avg}} \sqrt{\frac{T_{s(abs)}}{P_s M_s}}$$

where,

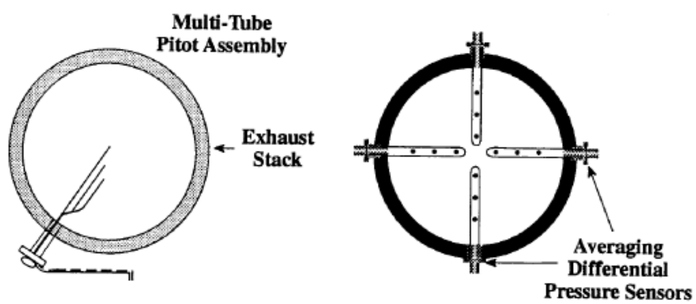
v_s = stack gas velocity
K_p = dimensionless constant
C_p = pitot tube coefficient
Δp = velocity pressure
$T_{s(abs)}$ = absolute temperature of the stack gas
P_s = absolute pressure of the stack gas
M_s = molecular weight of the stack gas

Usually the molecular weight of the flue gas and stack pressure are assumed to be constants and are not measured. Temperature measurements are made either with a thermocouple or resistence temperature device (RTD). The temperature probe should also be placed in a location representative of the stack flow profile.

The flow CEMS differential pressure probe may measure at one point in the stack, or at multiple points using a multi-point averaging probe or multiple pitot tube assembly. (See Illustration 2-7.)

Differential pressure monitors are sensitive to non-parallel or swirling flow. If the flow is at an angle to the stack center line there will be a bias in the velocity measurement. The bias is usually positive.

Illustration 2-8:
Example of Multiple Probe Locations (Jahnke, 1994)



Quality Assurance Issues

Probe and line plugging is minimized by intermittently back purging the line and probe openings with clean air. Back purging is required as a daily interference check (Part 75, Appendix A, § 2.2.2.2) and prevents extreme plugging in most situations. Daily calibration error tests are performed after the probe and test the pressure transducer and system electronics. The pressure side of the probe or transducer is pressurized to a pre-set level to check the span, and then both inputs are equalized to test the zero level. Because probes are subject to corrosion and abrasion, they should be visually inspected periodically in addition to these tests. Part 75 requires a quarterly leak check of all sample lines for a differential pressure flow monitor.

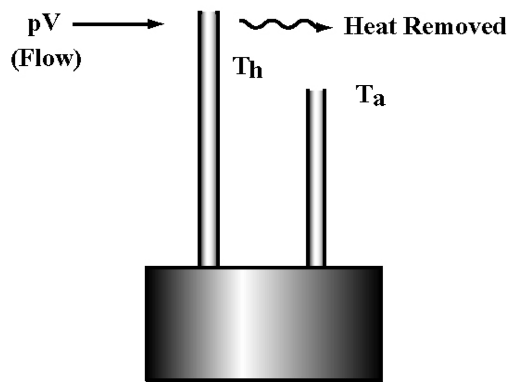
2.5.3 Thermal Mass Flow Monitors

Thermal mass flow monitors are based on the principle of thermal heat transfer due to convection. Gas flowing across a heated surface tends to cool the surface. The molecules of the flowing gas interact with the heated boundary layer surrounding the surface and remove heat. The greater the flow rate, the more heat is removed. There are two types of sensors used by thermal flow monitors: the constant power anemometer and the constant temperature anemometer.

Both types of anemometers use two RTDs, one heated and the other unheated. The RTDs are usually protected by a stainless steel tube and mounted together in the stack. The constant power anemometer measures the temperature difference between the RTDs at a constant current. The temperature difference responds proportionally to changes in velocity. The temperature difference will be high at low velocities (less cooling of the heated RTD) and low at high velocities (more cooling of the heated RTD). The constant temperature anemometer maintains a constant temperature difference between the RTDs by varying the current. The change in current is proportional to the change in gas velocity. The higher the velocity, the higher the current required to maintain the heated RTD temperature; conversely, at lower velocities a lower current is required.

The sensors can be placed at a single point if the flow profile or in a multiple point array depending on flow conditions.

Illustration 2-9:
Thermal Mass Flow Monitor Probe (adapted from Jahnke, 1992)



(T_h = Temperature of Heated RTD, T_a = Temperature of Unheated RTD)

The output from a thermal flow monitor (an empirical function dependent on the measured temperature difference, gas composition, and power to the anemometers) is proportional to mass flow. Information on the flue gas density is required to convert mass flow to volumetric flow. The gas density is dependent on fuel gas composition, so changes in moisture or CO_2 can affect the system's response.

$$f(heat\ loss) \approx f(T_v - T_s) = \rho v_s A_s$$

where,

where,	v_s	= stack gas velocity
	$f(T_v - T_s)$	= heat loss function
	T_v	= temperature of velocity sensor
	T_s	= stack temperature
	ρ	= gas density
	A_s	= stack cross sectional area

Thermal flow monitors can not be used in locations where there are entrained water droplets. The water droplets evaporate on the sensor causing a dramatic temperature loss due to the heat of evaporation, which would be interpreted as caused by the flowing gas. Corrosion and particulate build up on the sensors can be a problem.

Daily Interference and Calibration Error Tests

The daily interference test check requires a means to ensure on a daily basis that the probe is sufficiently clean to prevent interference (Part 75, Appendix A, § 2.2.2.2). The sensors are usually cleaned by self heating at temperatures of 700°F or higher to burn off any adhering particles or chemical compounds. Daily calibration error tests check that the sensors are operational and that the system electronics are functioning correctly.

2.5.4 Ultrasonic Flow Monitor

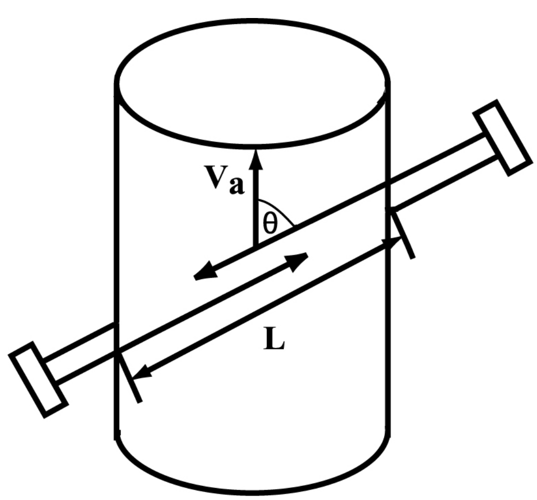
Ultrasonic flow monitors measure the time required for an ultrasonic pulse to travel across a stack or duct at an angle to the stack flow. The monitors are also called transit time monitors. The monitor consists of downstream and upstream transducers located opposite of each other on the stack wall which send and receive ultrasonic pulses. The difference in the time that it takes for the pulse to go in the different directions between the two transducers (the time it takes to go downstream is shorter than the time to go upstream) and the distance traveled are used to calculate velocity. The equation for an ideal flow profile is shown below.

$$v_a = \frac{L}{2 \times \cos\theta} \times [1/t_1 - 1/t_2]$$

where, v_a = average velocity of the flue gas;
L = distance between the transducers;
θ = angle of inclination;
t_1 = traverse time in upstream direction;
t_2 = traverse time in downstream direction

The most common angle of inclination θ, or path angle, between the transducers at Part 75 sources is 45°. Other angles are possible, and various designs and approaches are used to optimize signal recognition for better transmission, reception, reliability, and accuracy.

Illustration 2-10:
Ultrasonic Flow Monitor



The velocity of the sound pulse through the stack gas is affected by the stack gas density, so changes in the stack temperature due to load changes, and/or temperature variations across the sonic path, will affect the flow measurement. In some cases correction factors can be developed using the pre-RATA testing to account for these changes.

Non-parallel flow will also affect the ultrasonic monitor measurements. If the angle or pitch of the non-parallel flow is in the same direction from the stack center line as the measurement path inclination, the flow measurement will have a positive bias. The flow measurement will have a negative bias if the flow pitch angle and inclination angle are in opposite directions. Two ultrasonic monitors measuring along different path cross sections (an x-pattern) can be used in situations with a stratified flow profile that varies with load. One path is usually sufficient if the stratification is stable.

Daily Interference and Calibration Error Tests

Part 75 requires a means to ensure on at least a daily basis that the probe remains sufficiently clean to prevent interference (Part 75, Appendix A, § 2.2.2.2). Blowers are provided to keep the sensors clean much like on an opacity monitor. The blower air is heated to the temperature of the flue gas to prevent condensation, which may damage the transducer. Daily calibrations of this type of flow CEMS are indirect. The electronic calibration process verifies that the upstream and downstream sensors are working in both the transmitting and receiving modes. The procedure also verifies that the signal to noise ratio is acceptable.

2.6 Data Acquisition and Handling System (DAHS)

The term "data acquisition and handling system" (DAHS) refers to the CEMS hardware and software components that take the output from the analyzers, combine it with other information, and compute hourly emissions. The DAHS acquires and stores the necessary data (Part 75 requires that the DAHS automatically record all emissions data and the daily calibration error checks - Appendix A, § 4). It also computes the emissions and quality assurance test results in terms of the regulatory requirements, displays the data and produces the quarterly reports required by Part 75. The DAHS software for Part 75 is highly specialized to match the electronic data reporting (EDR) format.

In addition to a DAHS, a CEMS requires software/hardware components for system control functions. These functions include automatic calibration, probe blowback, analyzer sequencing for time-shared analyzers, error detection, diagnostic routines, and similar tasks.

2.6.1 CEMS Computer Systems

In general there are two approaches for a CEMS computer system. In one approach, a single computer handles both the CEMS control functions and the DAHS functions. In the other, there is a separate control system that handles the CEMS functions and may manipulate data as an interface between the analyzers and a separate DAHS computer. Because of the complexity of the control and DAHS functions in Part 75 CEMS, it is more typical to have separate systems for control and data acquisition and handling.

System control hardware options include computers, programmable logic controllers (PLCs), data loggers, and embedded microprocessors. Besides providing CEMS control functions described above, controllers also can provide some analyzer data processing prior to the DAHS. These may include converting analog data to digital, and performing some of the automatic correction calculations and emission calculations.

The DAHS computer is most often a stand alone personal computer, although some plants are using the plant's distributive control system (DCS).

2.6.2 Emissions Data Processing

The analyzers may send digital signals directly to the DAHS, or send analog signals that must be converted to a digital value and scaled. The real time, second-to-second data is first averaged (1-15 minutes) by the analyzer, control interface, or DAHS. Corrections may be applied to the data (e.g., pressure/temperature compensation, molecular weight, flow and moisture monitoring polynomials, sonic velocity correction factors, NO_x quenching correction factors, and dilution ratio settings), and the data then converted to the proper units for the Part 75 formula calculations.

The data must be averaged again to one-hour averages, as required by Part 75. A valid measurement must be recorded in each quadrant of the hour, except when performing required Part 75 QA testing (e.g., a daily calibration or quarterly linearity test). For hours in which Part 75 QA testing is performed, only two quadrants of the hour need to be captured (§ 75.10(d)(1)). The hourly data are then used to calculate the Part 75 emissions, parameters, and rates based on formulas in Part 75, Appendices D - G, with the CEMS-based formulas in Appendix F. A table of the required formulas is provided in the EDR v2.2 Reporting Instructions (August 2002).

2.6.3 QA Test Data Processing

As noted previously, Part 75 requires automatic data capture and calculation of daily calibration error test results. Other QA test data and results may be entered manually. Automatic and manual data entry for a Part 75 DAHS are discussed further in Section 4.6 of this manual, and in Section II.C.3 of the EDR v2.2 Reporting Instructions.

Some CEMS use the daily calibration error test results to automatically correct the analyzer data. These mathematical adjustments are similar to an internal bias adjustment factor in that the DAHS evaluates the response in comparison to the reference value and assigns from that time forward an adjustment factor which is used to adjust the data for reporting.

2.6.4 Part 75 Reporting

The DAHS generates the quarterly electronic data report (EDR) submitted by the source to EPA's Clean Air Markets Division. The EDR is in ASCII text format with each line representing a separate record, which includes plant and unit information, monitoring plan information, hourly monitoring data, and QA test results. The reports are sent directly to EPA by electronic data transfer. There is more discussion of the EDR in Section 3.1.1 of this manual.

2.7 References

Gschwandtner, G. and Winkler, J. (2001). *U.S. EPA, Acid Rain Program: Continuous Emissions Monitoring Systems Reference Manual.* U.S. Environmental Protection Agency, Acid Rain Division.

Jahnke, J. A.. (1992). *APTI Course 474, Continuous Emissions Monitoring Systems, Student Manual (Revised).* U.S. Environmental Protection Agency, Office of Air Quality and Planning Standards.

Jahnke, J. A. (1994). *An Operator's Guide to Eliminating Bias in CEM Systems*. U.S. Environmental Protection Agency, Office of Air and Radiation. EPA 430-R-94-016.

Jahnke, J. A., and Peeler, J. W. (1997). Handbook: Continuous Emission Monitoring Systems for Non-Criteria Pollutants. U.S. Environmental Protection Agency, Office of Research and Development. EPA/625/R-97/001.

Jahnke, J. A. (2000). *Continuous Emission Monitoring*, *Second Edition*. John Wiley & Sons, Inc.

Shigehara, R. T., and Peeler, J. W. (1998). *Evaluation of Daily Calibration Techniques of Continuous Flow Monitoring Systems.* U.S. Environmental Protection Agency, Acid Rain Division.

Section 3: Audit Preparation

Section 3 covers the data that are available to help you prepare for the field audit and explains how to use that data. Preparing for the audit can increase your efficiency by allowing you to target issues for auditing while at the plant. You also gain credibility with plant personnel if you come prepared. This section emphasizes the use of the MDC software to review quarterly electronic data.

3.1 Using Part 75 Electronic Data to Conduct Pre-Audit Reviews

You will have available two types of source file information in preparing for a Part 75 field audit. Hardcopy file information may include correspondence, petition responses, portions of the monitoring plan (such as system diagrams), reports of previous inspections or audits, performance test reports, and permits. This type of information may be similar to background file information available for other types of air compliance inspections and audits.

The second type of information is the quarterly electronic report required under Part 75. This wealth of electronic data generally is not available under other programs, and provides a valuable resource that you can use prior to the plant visit to conduct monitoring checks and to identify potential source monitoring problems. The electronic information includes data on the unit's monitoring plan, certification and recertification events, QA tests, and emissions and operating data for each hour of the quarter.

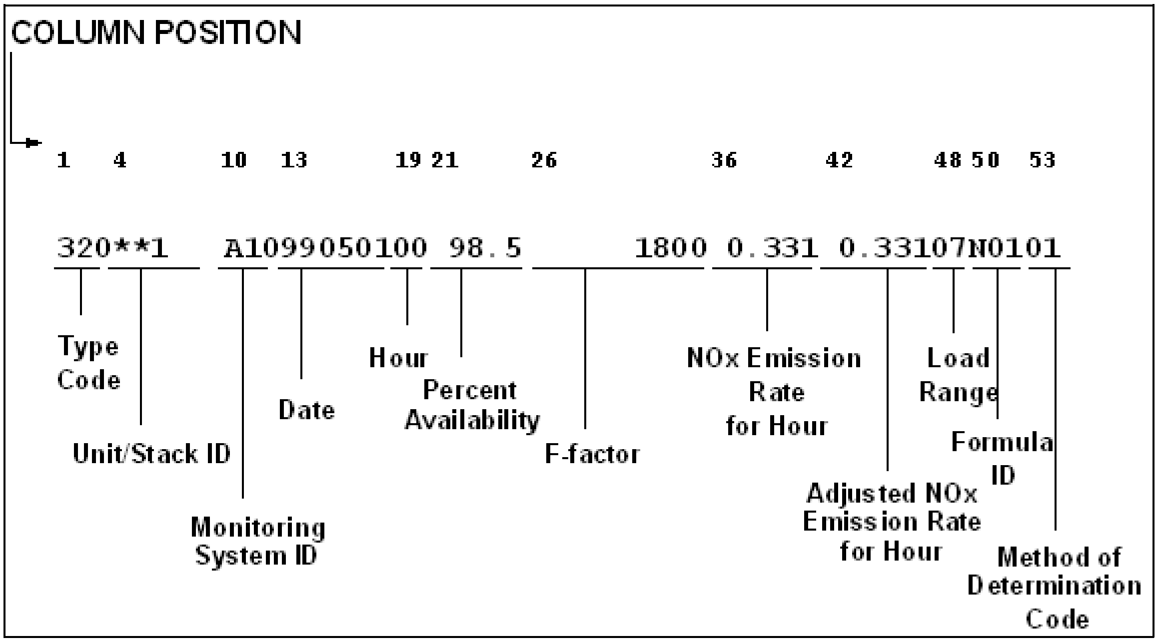
This section first introduces you to the quarterly Electronic Data Report (EDR). The section then describes how to review reports that EPA sends to affected sources to provide feedback on each EDR submitted. Finally, the section focuses on how to use EPA's Monitoring Data Checking (MDC) software to review EDRs.

The format and volume of the electronic data can be daunting at first, especially for inspectors who have responsibilities for multiple air programs. The MDC software will be a vital asset to help you access and analyze the EDR, and you should ensure that you take advantage of this tool as you prepare for an audit.

3.1.1 Quarterly Electronic Data Reports

A facility usually submits each Part 75 quarterly EDR on a unit basis, so one facility may submit multiple EDRs each quarter. In other cases, one report may be submitted for all units that exhaust to a common monitored stack or other complex stack configuration. The EDR is in ASCII text format, with each line representing a separate record referred to as a "record type" or "RT." An example of the layout of information in a report line or record type is provided in Illustration 3-1. In this example, a line of hourly NO_x emission rate data (RT 320) is presented. If you want to explore the structure and content of the EDR in more detail, you should review the most up-to-date version of the EDR Reporting Instructions and Formats -- see Section 1.5 for guidance on how to access the EDR guidance documents.

Illustration 3-1:
Example EDR Data Format for Record Type 320



To show you the various data elements you will see in an EDR, Illustration 3-2, below, provides an example summary of the content of an EDR by record type. The example is for two Acid Rain CEMS units monitored at a common stack. A number of these record types, like RT 320 in Illustration 3-1, above, pertain to emissions or operating data that are reported for each hour of operation, so a quarterly EDR will have many lines of data. A quarterly EDR for a unit with a single stack may have over 20,000 lines. An EDR in text file format therefore may look overwhelming, but the MDC software tool allows you to streamline your review and analysis of the data.

Illustration 3-2:
Example Summary Of Quarterly Report Content For Two Acid Rain CEMS Units Emitting Through Common Stack

FACILITY INFORMATION	
Type 100 Record	*(Facility and report data)*
Type 102 Record	*(Facility information)*
COMMON STACK FOR UNITS 1 & 2	
Type 200 Records	*(SO_2 concentration data: by date and hour)*
Type 201 Records	*(NO_x concentration data: by date and hour)*
Type 202 Records	*(CO_2 concentration data: by date and hour)*
Type 210 Records	*(Diluent data: by date and hour)*
Type 220 Records	*(Volumetric flow data: by date and hour)*
Type 230 Records	*(Daily calibration test data: by date and hour)*
Type 231 Records	*(Flow interference data: by date and hour)*
Type 300 Records	*(Stack operating parameters: by date and hour)*
Type 301 Record	*(Quarterly and cumulative emission data)*
Type 310 Records	*(SO_2 mass emissions data: by date and hour)*
Type 320 Records	*(NO_x emission rate data: by date and hour)*
Type 330 Records	*(CO_2 mass emissions data: by date and hour)*
Type 503 Records	*(For Unit 1 (Common stack definition table))*
	(For Unit 2 (Common stack definition table))
Type 510 Records	*(Monitoring systems/analytical components table)*
Type 520 Records	*(Formula table)*
Type 530 Records	*(Span table)*
Type 535 Records	*(Stack operating load data)*
Type 536 Record	*(Range of Operation, normal load, and load usage)*
Type 556 Records	*(Monitoring system recertification events)*
Type 601 Records	*(Quarterly linearity test data)*
Type 602 Records	*(Quarterly linearity check results)*
Type 603 Records	*(Flow quarterly leak check results)*
Type 605 Records	*(Reference data for flow-to-load ratio or GHR evaluation)*
Type 606 Records	*(Quarterly flow-to-load or GHR check)*
Type 610 Records	*(RATA and bias test data)*
Type 611 Records	*(RATA and bias test results)*
Type 623 Records	*(On-line/Off-line calibration demonstration)*
Type 699 Record	*(QA test extension claim based on grace period)*
UNIT 1 (MONITORED AT COMMON STACK)	
Type 300 Records	*(Unit operating parameters: by date and hour)*
Type 301 Record	*(Quarterly and cumulative emission data)*
Type 504 Record	*(Unit information)*
Type 505 Record	*(Unit/program information)*
Type 585 Records	*(Monitoring methodology information)*
Type 586 Record	*(Control equipment information)*
Type 587 Record	*(Unit fuel type)*
UNIT 2 (MONITORED AT COMMON STACK)	
Type 300 Records	*(Unit operating parameters: by date and hour)*
Type 301 Record	*(Quarterly and cumulative emission data)*
Type 504 Record	*(Unit definition table)*
Type 505 Record	*(Unit/program information)*
Type 585 Records	*(Monitoring methodology information)*
Type 586 Record	*(Control equipment information)*
Type 587 Record	*(Unit fuel type)*
CERTIFICATIONS	
Type 900 Records	*(Certification electronic signature)*
Type 901 Records	*(Certification statement)*
Type 999 Record	*(Contact person information)*

3.1.2 Quarterly Feedback Reports

CAMD conducts two separate automated reviews of each quarterly EDR submission. The first is generated by the Emission Tracking System (ETS) as "instant feedback" when the source submits the file to the EPA mainframe. This instant ETS feedback provides the EPA "Status Code," which indicates whether the file was accepted and whether any errors were identified. Certain errors are considered critical and necessitate a resubmission of a corrected file. Other errors are considered informational and should be corrected by the source in future quarters but need not necessarily be addressed immediately. Any errors that are identified are listed in the ETS feedback report with the relevant error code, description, number of hours and identification of the first hour in which the error occurred. ETS checks include recalculations of hourly and cumulative emission values, as well as range checks for acceptable values and codes in various fields.

As part of preparing for a field audit, you can download the ETS feedback report from the EPA mainframe (if you have access rights) or you can request a copy of the feedback from your CAMD contact. If errors were identified on the latest ETS feedback, you should review this report with the source during the on-site inspection and verify that the source has corrected those errors.

The second automated review is generated by the Monitoring Data Checking (MDC) software and is sent by email to a facility's Designated Representative shortly after the quarterly EDR submission period. The MDC feedback consists of monitoring plan and QA test data evaluations. As with the ETS errors, certain MDC errors are considered critical and must be corrected by a resubmission of the quarterly file. Note that since MDC is available to sources to download from the CAMD website, they can run these same evaluations on their quarterly files prior to submission. The MDC software is discussed in more detail in the following sections, with guidance on how you can use the software to prepare for the plant visit.

3.1.3 Using MDC to Prepare for an Audit

3.1.3.1 MDC Overview

EPA developed the MDC software to allow affected sources, State agencies, and EPA staff to enter, analyze, print and export electronic monitoring plan, certification and quality assurance data, and to evaluate hourly emissions data for Part 75 monitoring. The software also allows industry users to submit monitoring plan and certification data to EPA through standard electronic data transfer protocols.

Key Checks: Using MDC to Prepare for the Field Audit

- Print a copy of the monitoring plan report to take with you to the plant.
- Evaluate QA Test results (e.g., linearity, RATA, flow-to-load), and check for duplicate tests. Identify if the source has claimed an exemption or grace period.
- Print and review recertification reports. Also print missing data reports if available.
- Check hourly emissions, calculations, and missing data periods using the MDC Hourly feature.

To prepare for an audit, you can use MDC to perform the following tasks in reviewing the quarterly EDR data:

- View monitoring plan, QA test, extension/exemption, and compliance certification records directly on screen.
- Evaluate monitoring plans, quality assurance tests, and extension/exemption records.
- Print out reports of monitoring plans, QA test data, or evaluations.
- Analyze hourly data with the MDC Hourly data module.
- Analyze, view and chart hourly data records for SO_2, CO_2, O_2, NO_x, and heat input. Also, calculate and display summary data for daily, monthly, and quarterly time periods.
- Check hourly emissions calculations. (MDC relies on the calculation procedures identified in a unit's monitoring plan together with RATA test data for these calculations.) You can also calculate cumulative emissions from the hourly data to compare to the quarterly and annual values that the source reports in the EDR (see RTs 301 and 307).
- Check to determine the quality assurance status (with respect to RATAs and linearity tests) of measurements reported for specific hours and monitors. (MDC uses the ongoing reported quality assurance test data and extension/exemption records for this analysis.)
- Archive hourly data calculations and QA status for quick retrieval.
- Use a utility in MDC to modify parameter tolerances for comparisons of reported versus calculated hourly emissions.

The following subsections address these uses in greater detail.

3.1.3.2 Getting Started with MDC

The most current version of MDC along with instructions and training materials are available on CAMD's website. Once you obtain MDC and install it on your computer the next step is to import recent EDRs for the units to be audited. You will need first to obtain the quarterly EDRs, which can be downloaded from CAMD's website or received on a CD from CAMD.

> **Obtaining MDC Software**
>
> EPA's MDC Software and supporting information can be downloaded at: www.epa.gov/airmarkets/monitoring/mdc.

The EDR files should be saved in the data folder of the MDC directory. You may need as many as four quarters of the most recent EDRs for the units, and may need to go back additional quarters depending on when the most recent RATA was performed. QA tests are included in the EDR for the quarter during which the tests were performed.

3.1.3.3 Review and Print Electronic Portion of Monitoring Plans

The electronic portion of a monitoring plan provides important background information. The plan identifies the affected units (e.g., type, rated capacity, fuels combusted), control equipment, what types of monitoring systems and components are in use, monitor span values, DAHS formulas, missing data procedures, and other information. (See Table 3-1.)

The plan should be printed out using the MDC reports function and brought to the plant. The plan printout provides a simple template and check sheet for the plant visit. For example, when verifying monitor serial numbers to ensure that equipment has been properly certified you may simply check off on the printed monitoring plan each monitor system component that matches, and include this as a check sheet in the audit report.

Table 3-1:
Electronic Monitoring Plan Information

Electronic Monitoring Plan Records	Description
Unit Operation Information (RT 504)	Unit ID, Boiler Type, Maximum Heat Input, Areas at Flow Monitor and Stack Exit
Monitoring Systems/Analytical (RT 510) Components	System Parameter and ID; Component ID, Type, Sample Method, Manufacturer, Model, Serial Number
Emission Formulas (RT 520)	Parameter, Formula Code, Formula
Span Values (RT 530)	Parameter, Scale, MPC/MEC/MPF, Max. NO_x Rate, Span Value, Full-Scale Range, Units of Measure
Load Range (RT 535)	Maximum Hourly Load
Range of Operation (RT 536)	Upper and Lower Bounds of Operating Range, Most Frequently Used Loads, Normal Load
Monitoring Methodologies (RT 585)	Parameter, Methodology, Fuel Type, Missing Data Approach
Control Information (RT 586)	Parameter, Type of Control, Control Dates
Fuel Type (RT 587)	Primary/Secondary Fuels
Fuel Flow Meter Data (Appendix D) (RT 540)	Parameter, Fuel Type, Maximum Fuel Flow, Initial Accuracy Test Method
Fuel Usage Qualification (Appendix E) (RT 507)	Capacity or Gas Usage, Qualification Type, Method
NO_x Correlation Segments (Appendix E) (RT 560)	Test Date, Test Number, Operating Level, Segment, Heat Input, NO_x Rate, Fuel Type

3.1.3.4 QA Tests, Exemptions, and Extensions

The MDC program evaluates QA test data and provides detailed test reports. You can view a list of the QA tests (linearity, flow-to-load, and RATAs) -- as well as any test grace periods and exemptions -- in the EDRs that you have imported into MDC by selecting Certification and QA Tests or Test Extensions and Exemptions from the Edit or Report pull down menus.

> **Part 75 QA Tests**
>
> In the context of Part 75 and this manual, QA tests refer to quality assurance tests required by the rule. The primary tests for electronic data evaluation using MDC are:
>
> - Linearity Tests
> - Relative Accuracy Test Audits (RATAs)
> - Flow-to-Load Tests

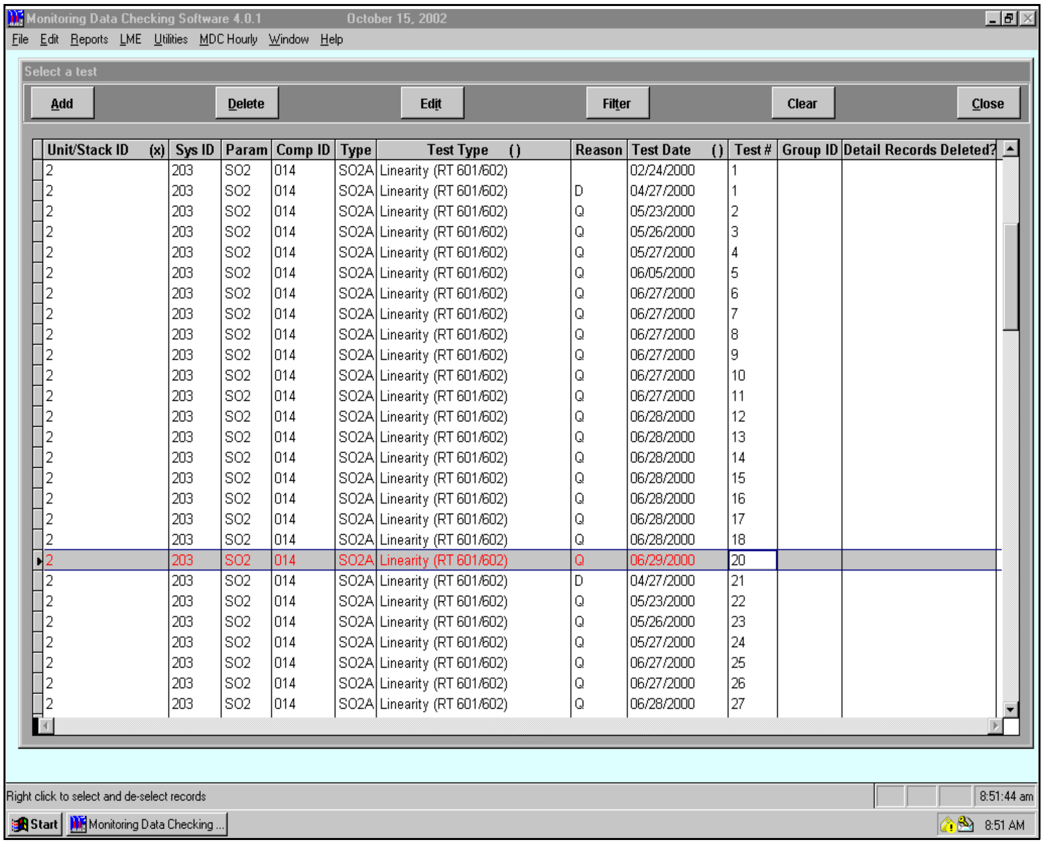
QA Tests

MDC will evaluate QA test data, and provide brief error messages if errors are found. For example, low, medium, and high gas levels are compared to the instrument span to determine if the linearity was performed at the appropriate levels. The program also will re-calculate linearity and RATA results including RATA bias adjustment factors (BAF). These are the same evaluations that are performed by CAMD at the end of each quarter, described above in Section 3.1.2.

If you have not received a copy of CAMD's evaluation, you should run QA test evaluations of all the QA tests performed in the quarters you have downloaded. Make a note of errors; also, you can print out specific pages of the MDC evaluation report for follow up with the plant during the audit visit.

In addition to the test evaluations, you will want to view the list of QA tests performed by the source to see if a particular QA test (RATA or linearity) has been repeated in a quarter. This would indicate a failed or aborted test that might be due to CEMS problems. You should investigate these failed/aborted tests during the plant visit to find out what adjustments (if any) were made to the system and why they were necessary. To perform this check, view the list of QA tests for a source by using the 'Edit' pull down menu in MDC. An example is shown in Illustration 3-3, where the SO_2 linearity test has been repeated multiple times for a unit during the second quarter of 2000.

Illustration 3-3:
MDC Screen Showing Multiple Linearity Tests in One Quarter


Monitoring Data Checking Software 4.0.1 October 15, 2002
File Edit Reports LME Utilities MDC Hourly Window Help
Select a test
Add Delete Edit Filter Clear Close

Unit/Stack ID (x)	Sys ID	Param	Comp ID	Type	Test Type ( )	Reason	Test Date ( )	Test #	Group ID	Detail Records Deleted?
2	203	SO2	014	SO2A	Linearity (RT 601/602)		02/24/2000	1		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	D	04/27/2000	1		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	05/23/2000	2		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	05/26/2000	3		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	05/27/2000	4		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/05/2000	5		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/27/2000	6		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/27/2000	7		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/27/2000	8		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/27/2000	9		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/27/2000	10		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/27/2000	11		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/28/2000	12		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/28/2000	13		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/28/2000	14		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/28/2000	15		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/28/2000	16		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/28/2000	17		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/28/2000	18		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/29/2000	20		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	D	04/27/2000	21		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	05/23/2000	22		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	05/26/2000	23		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	05/27/2000	24		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/27/2000	25		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/27/2000	26		
2	203	SO2	014	SO2A	Linearity (RT 601/602)	Q	06/28/2000	27		

Right click to select and de-select records 8:51:44 am
Start Monitoring Data Checking ... 8:51 AM

You should also print out copies of a number of RATA and linearity test reports to bring with you to the plant so that you may compare the results reported in the quarterly EDR to on-site test report records. You should perform this check (see Section 4.6) to ensure that the source properly transferred QA test data not automatically recorded by a CEMS to the CEMS data acquisition and handling system (DAHS).

Extensions and Exemptions

The Part 75 rule allows for the extension of QA test deadlines, and, in some cases, exemptions from QA test requirements based on specific unit circumstances. Test extensions are available for RATAs and quarterly Appendix D fuel flowmeter accuracy tests. There is also a general "grace period" extension for all quarterly QA tests and RATAs, which allows time in which to complete the testing for a short period after the end-of-quarter deadline.

Exemptions are available from the multi-load flow RATA requirement (flow RATA may be allowed at a single operating level), SO_2 RATA requirement (for units burning a low sulfur fuel), and the requirement to perform a single load RATA at normal load. In addition, quarterly QA test exemptions are available for linearity tests, leak checks, and flow-to-load ratio tests in any quarter which does not qualify as a QA operating quarter (a QA operating quarter has at least 168 hours of stack or unit operation). Quarterly QA test exemptions are also available for linearity tests of one range of a dual range monitor (range not used in the quarter), linearity tests of SO_2 or NO_x monitors with spans of 30 ppm or less, and flow-to-load ratio tests for complex stack configurations that have been approved by petition. The EDR v2.2 Instructions (see sections that discuss RT 695 - RT 699) provide useful background descriptions of the available extensions and exemptions and qualification requirements. A link to the EDR Instructions is provided in Section 1.5 of this manual.

You can use MDC to determine whether the source has claimed any extensions or exemptions. Select 'Test Extensions' and 'Exemptions' from MDC's Report pull down menu. Then, run an evaluation report for all of the extensions and exemptions to determine if there are any errors that require follow-up during the field audit.

Extension and Exemption Record Types

- RT 695: Single-Load Flow Rata Claim
- RT 696: Fuel Flowmeter Accuracy Test Extension
- RT 697: RATA Extension or Exemption
- RT 698: Quarterly QA Test Exemption

A common test exemption is the use of a 1-load level RATA for flow RATAs. Generally, a 2-load test is required for QA testing. At least once every 5 years, a 3-load test is required for quality assurance purposes. In addition, a 3-load test is required for certification and recertification.

There are also a few situations in which a 1-load test is allowed without a special exemption: (1) peaking units and bypass stacks automatically qualify; (2) a source that conducts flow RATAs on a semiannual basis can alternate between a 2-load and 1-load test; and (3) cement kilns and other non-load based units can conduct tests at a single level if representative of normal operations. For other sources to qualify to use a 1-load level flow RATA, the source must submit the results of the single load analysis required by Appendix B, § 2.3.1.3(c) in RT 695. Check to make sure that flow RATAs were performed at multiple loads (or that a unit otherwise qualified for a single load test) if the MDC exemption report indicates that the source did not report RT 695.

Table 3-2:
Summary of MDC QA Test Checks

QA Test Checks	Description
QA test evaluations	MDC will evaluate QA test data, recalculate results, and provide error messages if errors are found.
Repeated QA tests	Look for Failed/Repeated QA Tests (multiple tests in a quarter).
Print RATA and linearity reports for comparison with on-site hardcopy data	Bring the reports to the plant to make sure the electronic data match hardcopy data. For linearity tests, make sure the reference cylinder gas concentrations match those on site.
Extensions and grace periods	Identify if the source has claimed an extension or grace period.

(cont.)

Table 3-2:
Summary of MDC QA Test Checks (cont.)

QA Test Checks	Description
Single load flow RATAs (RT 695)	Check for the exemption analysis, single load flow RATA claim record (RT 695), which will show the results of the single load analysis required by App. B, 2.3.1.3(c). Make sure flow RATAs were performed at multiple load levels for units (other than peaking units) without the single load exemption request. Note: Non-peaking units performing RATAs semiannually can alternate between single-load and multiple-load test without requesting an exemption or reporting RT 695. Certain non-load based units (such as cement kilns) also may be exempt from multiple-level tests.

3.1.3.5 Recertification Events and Monitoring System Downtime Reports

Sources must report certification, recertification, and certain maintenance events in the quarterly EDR (RT 556) in the report for the quarter in which the event occurred. The MDC report function (currently under the Reports drop down menu) can provide a printout report of recertification and maintenance events. This report identifies certification, recertification, and maintenance events and what QA tests were required. If any of these records have been reported, you should print a copy of this report and bring it with you on the plant visit to compare against the plant records. It is important that all monitoring components are properly certified. If there have been changes to equipment, proper diagnostic or recertification testing should have occurred as required by § 75.20(b). Note that MDC does not verify that all required certification, recertification or diagnostic testing is included in the report. EPA therefore relies on the inspector to make this verification as part of the audit.

A Monitoring System Downtime or Missing Parameter Report (RT 550) may also be available, though unlike the Recertification Report (RT 556), this record is optional. This useful report shows the start and end time of all missing data periods by monitoring system, reason for missing data, and the corrective action taken. You can print out a copy of this report, and use the report to: (1) target monitoring system problems for further investigation with plant personnel during the plant visit, and (2) identify missing data periods that can be used in reviewing plant maintenance plan records or control device parameter records at the plant. Alternatively, if this report has not been submitted, the MDC Hourly function can be used to identify missing data periods, as discussed in the following section.

3.1.3.6 Using MDC Hourly to Check Emissions Data and Calculations

The MDC Hourly module analyzes, calculates, views and graphs the hourly emissions data records for SO_2, CO_2, O_2, NO_x, flow and heat input. It also calculates and displays summary data for daily, monthly and quarterly time periods. The program can analyze up to 4 quarters of calendar year data. MDC Hourly was designed for use with EDR v2.1. Use of EDR v2.1 began in the second quarter of 2000.

Getting Started with MDC Hourly

In order to check the hourly calculations with MDC Hourly you will need to make sure that you have imported quarterly EDR files that include the quarter with data from the most recent pollutant and flow RATAs so that you can take full advantage of the MDC data checks. If you do not import all of the historical monitoring plan and quality assurance data into MDC prior to running MDC Hourly, MDC Hourly may mistake hourly data as being out of control (OOC) and will not provide any further analysis on those hours.

Hourly Calculations and Error Messages

View the Detailed Emissions Data tables for the different CEMS. The program recalculates emissions for each hour using the monitoring plan formula and provides an error message in the far right column if there is a discrepancy. There is no need to perform the emission calculations yourself. One issue is the bias adjustment factor (BAF). If a source uses the wrong BAF, they could underreport emissions and undermine the integrity of the trading program. This recalculation feature in MDC can assist you in spotting this problem and understand the potential magnitude of the impact on emission allowances.

Error messages will also identify OOC periods, which indicate that a QA test (RATA or Linearity) was expired, failed, or not performed. MDC Hourly does not currently determine the control status of the unit with respect to daily calibrations. Be careful of the 'out-of-control' error messages you may generate when you run MDC Hourly. As noted in the *Getting Started* discussion above, you can receive these error messages if you do not import the data into MDC for the quarter in which the RATA was performed prior to running the analysis on the hourly data.

Missing Data Periods

Use the filter function to identify missing data periods. This is especially important if the source did not submit the optional RT 550 record described above in Section 3.1.3.5. The reasons for the missing data are not provided, but this information may be used to identify systems with high amounts of missing data to target during the plant visit, and also to select missing data periods for an in-plant records review.

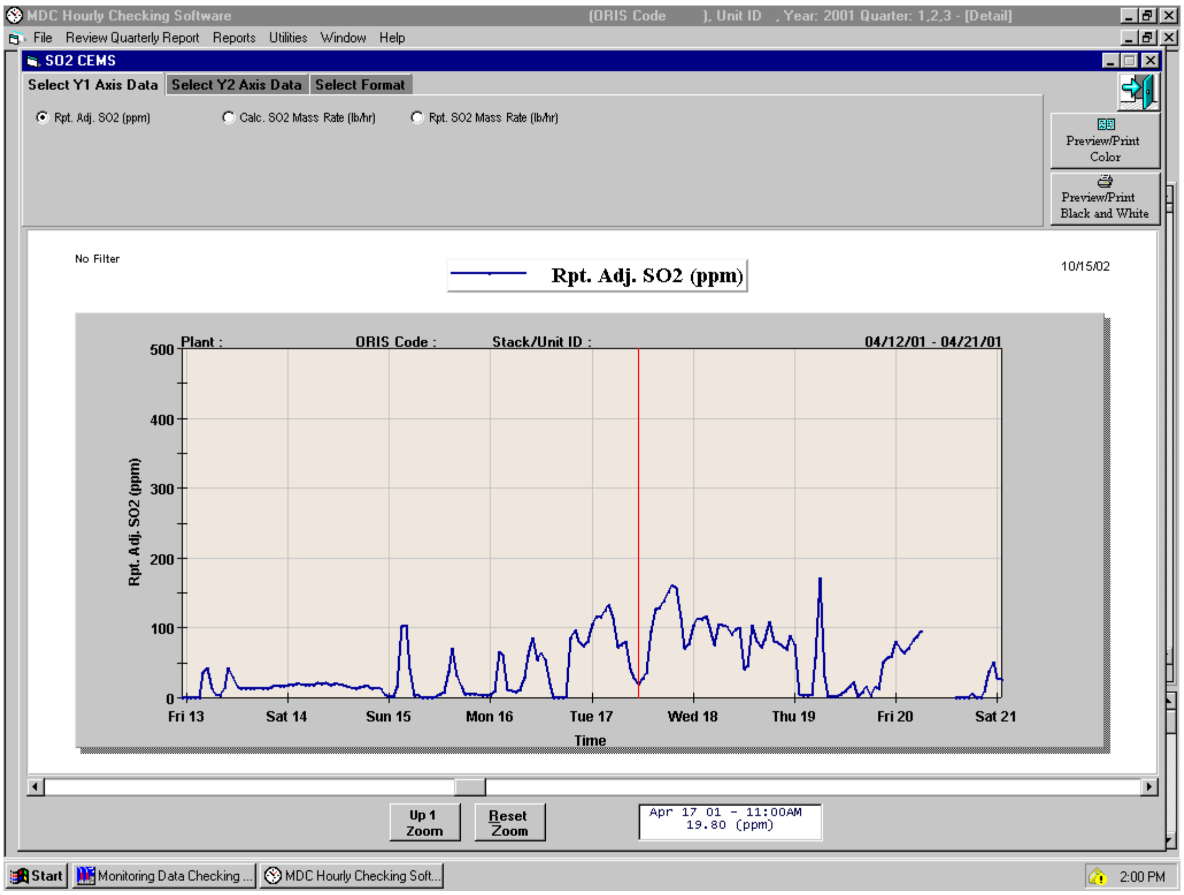
Appendix D Units

For oil- or gas-fired units that use Appendix D fuel monitoring to determine heat input and SO_2 emissions, view and record the fuel gross caloric value (GCV) and sulfur content across quarters so that you can check these values against on-site fuel sampling and analysis results.

Graphing

MDC Hourly's graphing function allows you to graph the hourly emission data as well as flow and heat input. Graphing emissions data can be an invaluable tool for preparing for a field audit. Graphing allows the inspector to verify that the reported emissions look reasonable for the type of unit being evaluated. Abnormal emission trends can often be quickly identified and should be investigated as part of the field audit to identify if the abnormality is due to a problem with the monitoring system or to a change in the way the unit is operated. An abrupt or unusual change could indicate a modification to unit operation or the CEMS that may require recertification or diagnostic testing. Consistent data with very little change (flat line) may indicate that the CEMS is not operating properly, or that the unit is using a missing data routine. Either situation should be investigated with the source during the on-site visit.

Illustration 3-4:
Example MDC Hourly Graph of SO_2 Concentrations



The graphing function also can be used to compare the hourly emissions or parameter (flow, heat input) against the monitor span values listed in the monitoring plan. You should note if the emissions or parameter exceed the relevant maximum potential concentration (MPC), maximum expected concentration (MEC), or maximum potential stack gas flow rate (MPF). The emissions should typically be between 20 and 80 percent of the monitor range identified in the monitoring plan. (See Appendix A, § 2.1.) If a majority of the emission/parameter readings are outside 20 to 80 percent of the monitoring range, you should make sure that the source has performed the MPC, MEC, span, and range checks that are required at least annually by Appendix A, § 2.1.

Table 3-3:
Summary of MDC Hourly Checks

MDC Hourly Checks	Description
Check hourly calculations and error messages	Check recalculated hourly emissions for error messages, which are provided for each hour in the far right column. Error messages also identify out of control periods, which indicate that a QA test was failed or was not performed. Hourly error messages may need to be ignored if the most recent RATA for a parameter was not imported.
Check BAFs used in hourly calculations	MDC Hourly will use the BAF in the most recent RATA to recalculate hourly emissions.
Check missing data periods	Use the filter function to identify missing data periods. Identify systems with high amounts of missing data, and to select missing data periods for in-plant records review.
For oil or gas units using Appendix D, note fuel GCV and sulfur content	View and record these values across quarters to check against on-site fuel sampling and analysis results.
Check spans	Use the graph function to compare the hourly emissions or parameter (flow, heat input) against the monitor span values in the monitor plan report. Follow-up with the source if emissions/parameters are higher than the span. The source is required to perform a span/range check at least annually (App. A § 2.1).
View graphs of data trends	Use the graph function to plot emissions and flow. Note any abrupt changes in the data or consistent data with no change.

3.2 Hardcopy File Review

In addition to the electronic review of monitoring plan and quarterly report data, you should also review the source's file for written correspondence and information pertaining to Part 75 monitoring. These documents would include any petitions, previous audit/inspection reports, linearity and RATA reports, and the source's acid rain permit or operating permit.

3.2.1 Correspondence, Petitions, and Previous Audit/Inspection Reports

Correspondence and any petitions provide background on any recent issues or unusual monitoring situations that may come up during the plant visit. Previous audit or inspection reports serve the same purpose. Also, if a prior report identified problems that required follow-up, you should confirm (either through your pre-audit review or on-site audit) that the source took appropriate corrective action.

3.2.2 Linearity Test and RATA Reports

Some States require a hardcopy submittal of linearity test and RATA reports. If this is the case in your State, and you have access to the reports in your office, you should compare the hardcopy results to those reported electronically and accessed with the MDC program as described in Sections 3.1.3 and 4.5, so that you will not have to conduct the comparison while at the plant. You can also review the RATA test report as described in Table 3-4. The hardcopy RATA test report review should be focused on reference method documentation that can not be checked electronically (e.g., reference method analyzer bias/drift checks, cylinder gas certifications, reference method equipment calibrations, traverse points, etc.).

Table 3-4:
RATA Report Review

RATA Hardcopy Review	Explanation
For a NO_x RATA using the instrumental method 7E, is the NO_x converter efficiency documented through a performance test?	The NO_x converter converts NO_2 to NO. NO is measured by the analyzer. If the NO_2 concentration is greater than 5 ppm, a NO_x converter efficiency test (RM 20) is required.
If an instrumental RM was used, were cylinder gas certificates included in the test report?	The calibration gas certificates should be provided in the test report and show: • Certified gases (EPA Protocol, NIST, etc., see Section 4.5). • Concentrations which match those used in the bias/drift check calculations. • Expiration date after the RATA.
For instrumental methods (6C, 7E, 3A), were the appropriate bias and drift corrections made for the RM data?	Run results are corrected for bias based on the average of the before and after bias checks.
For flow reference methods, is the calibration date of the pitot tube within 6 months of the RATA?	The most recent calibration should have been performed within 6 months of the test.
Are CEMS and RM data on same moisture basis?	Make sure the comparison between the CEMS and RM are on the same basis.

3.2.3 Permits

You should make sure that the source has an Acid Rain permit or NO_x budget permit, if required. Check any relevant source specific provisions related to Part 75 monitoring in the permit, and bring a copy of those provisions with you on the audit. The permit conditions for Part 75 monitoring, however, may only list a general requirement to follow Part 75, and not be that helpful.

3.3 Scheduling and Coordinating the Audit

Level 2 audits require coordination with the source to obtain their schedule for performing RATA and linearity performance tests. The source is required to provide written notice of the date of periodic RATAs no later than 21 days prior to the first scheduled day of testing (§ 75.61(a)(5)). Written notification may be provided by mail or by facsimile, and may be provided by electronic mail if the EPA Regional Office or State agency determines that electronic mail is acceptable (§75.61(a)(5)(i)). However, the date can be changed and often is due to operating constraints at the plant or with the CEMS. Part 75 allows performing a test on a different date as long as notice of the new date is provided as soon as practicable, but no later than twenty-four (24) hours in advance of the new test date.

Notice is not required prior to the quarterly linearity tests. So, you will need to coordinate with the facility staff to schedule your audit to coincide with a linearity test date, if desired.

Because the audit policy is "hands-off," you should review all of the inspection procedures and requirements at the time of scheduling to allow the facility the opportunity to gather the necessary information and arrange for the appropriate personnel to be available. (The plant environmental contact may also not be authorized to access the CEMS.) Prior knowledge of all procedures and the audit objectives will help to avoid problems and will allow the audit to proceed as planned and in a timely manner. You should also check plant-specific safety requirements with the source, and what safety equipment you will need.

Level 1 unannounced audits of a Part 75 monitoring system are often performed as part of the overall unannounced air compliance inspection of the facility. If you conduct a Level 1 audit as part of an unannounced inspection, you should also go over the inspection procedures and requirements as outlined in the previous paragraph when you arrive at the facility. Unannounced audits may not be as productive since the sources often rely on outside contractors or personnel from other sites to perform certain tasks. It is therefore more productive to coordinate with the source before the audit to make sure that the proper personnel are present to answer any questions that might arise during the audit.

3.4 Materials to Bring

The inspector should bring personal safety equipment (e.g., hard hat, safety glasses, safety shoes, hearing protection, etc.) as provided by agency policy. Useful materials and data sheets to bring on the field audit include:

> **Note!**
>
> Section 1.5 of this manual contains information to help you find related documents, including regulatory text for Part 60 and Part 75, and the Parts 75 and 76 Policy Manual.

- MDC printout of the monitoring plan
- MDC printout of linearity and RATA reports
- MDC printout of recertification and missing data reports
- Appropriate Part 60 reference method requirements if observing a RATA

- Checklists and data entry forms (see Appendix A of this manual)
- Part 75 Rule (see easy-to-use version maintained on CAMD's website)
- Parts 75 and 76 Policy Manual (bring and leave in car for reference as needed)
- Copy of Acid Rain permit or operating permit monitoring provisions

Section 4: On-Site CEMS Inspection

Outline of Section 4

This section describes the primary on-site activities that will apply to any field audit for a Part 75 CEMS. The field audit will consist of an initial interview (Section 4.1), the walk through and inspection of the various components of CEMS (Sections 4.2 - 4.7), and a review of QA and maintenance records (Sections 4.8 and 4.9). If you are conducting a Level 2 audit, you will also observe performance tests (Section 5). For a Level 3 audit, you will conduct certain performance tests (Section 6). In each case, you will complete your audit with an exit interview and final report (Section 7).

You should not consider the organization of this section as suggesting a specific order to the audit. For example, this section discusses conducting a walk-through visual observation of all equipment first, followed by a review of the QA/QC plan and recordkeeping. In many audits, you may go back and forth between visual observations and records review.

In budgeting your time you should spend more time on items that can not be checked or verified off-site from EDR submittals or other file information. In addition, focus on any potential problems flagged during the pre-audit review. For example, focus on CEMS and time periods with the most missing data, multiple failed QA tests, unusual data trends, or mistakes in emissions calculations. If you analyzed information using MDC or MDC Hourly, bring a specific list of the questions and issues based on these pre-audit activities.

In conjunction with your own visual observations and records review, interviews with plant staff provide important information on how the monitoring systems work and are operated, as well as on compliance with Part 75 requirements. You should ask the staff how they operate the equipment and perform QA activities, and how the QA/QC plan is used in relation to the different CEMS and quality assurance components. A key auditing technique is to establish a dialogue with personnel at the source and to let them answer your questions by going through their procedures and showing you where they document the procedures.

You will want to confirm that actual equipment settings, monitor operations, and quality assurance activities match the QA/QC plan. The QA/QC plan is an important resource and a Part 75 requirement. The QA/QC plan is the document that provides detailed procedures for how the CEMS is to be operated. If a source is following a complete QA/QC plan that covers all of the Part 75 quality assurance requirements and the operating parameters for the monitoring systems, then the data can be considered valid at all times that the system is operating within those parameters since the system is being operated as it was during the RATA. If the QA/QC plan is not followed or is incomplete, then it is questionable whether the emissions data are of the same quality as was demonstrated during the RATA. You may also find that the procedures currently in use are appropriate, but the QA/QC plan has not been updated. Many of the recommended checks in this manual refer back to the QA/QC plan.

One critical step is to verify that the CEMS components match those in the monitoring plan. If changes have been made, you need to determine if the proper recertification testing or diagnostic testing has been performed. Part 75 quality assurance begins with the initial certification of the CEMS, and any changes since that certification need to be evaluated for their effect on CEMS data.

Identifying Monitoring Hardware Recertification Issues

Recertification is required for a replacement, modification, or change that may significantly affect the ability of a CEMS to accurately measure monitored parameters:

- Complete System Replacement
- Analyzer Replacement
- Change in Orientation or Location of Sampling Probe or Site
- Change in Flow Monitor K factor or Polynomial

This is a key issue for audits. See Section 1.5 of this manual for a link to CAMD's guidance on recertification under Part 75.

4.1 Pre-Audit Interview

You should conduct a pre-audit meeting when you arrive at the plant. The meeting should include the plant contact, the plant CEMS technician assigned to assist with the audit, and may include plant management personnel. At this time, it is important for you to make sure the plant personnel understand the general scope of the audit, and to agree upon a tentative audit schedule so that necessary personnel will be available when needed. Table 4-1 identifies several items you should discuss in the interview.

Table 4-1:
Pre-Audit Interview Items

Topic	Purpose
Audit purpose and agenda	• Inform facility of the purpose and scope of the audit. • Streamline subsequent activities. • Allow for meetings with necessary plant personnel.
Inspection and audit techniques to be used including hands-off policy and the need for a CEMS technician	• Streamline subsequent activities. • Identify plant contacts for different parts of the audit.
Specific areas to be observed	• Identify any constraints on visiting locations in the plant.
Safety requirements	• Identify necessary safety equipment and plant safety issues.
Records to be reviewed and copying needs	• Streamline subsequent activities. • Provide source an opportunity to collect information during the other audit activities.
Notify plant personnel of intent to take photographs or videos to document observed conditions	• The inspector should ask for permission to take photographs on the plant property and explain the purpose for the photos. The source can make a confidentiality claim, but emission-related information is public information under the Clean Air Act. You should follow your agency's policy on the treatment of confidential business information claims. This is not likely to be an issue if photos or videos are limited to the CEMS components.

4.2 Calibration Error Test

Part 75 requires a daily calibration error test. This test provides a simple check of most CEMS components, and can detect many, but not all, sources of potential error in the monitoring system.

If possible you should observe routine daily calibration error tests as part of any CEMS field audit, but often the tests are initiated automatically at a specific time of day. Following the calibration sequence, the DAHS will typically generate a calibration summary report (presenting the CEMS responses and calculated calibration error results) to record the data for each operating day. Daily calibration check results are also reported electronically in the EDR.

If the daily checks have occurred before you arrived at the plant, review the results of the tests for that day and request the plant contact or CEMS technician to initiate a routine daily calibration test. Ask for an explanation of how daily calibrations are performed, how the results are used, what responses will trigger adjustments, and how adjustments are made. The specific procedures used to conduct this calibration routine should be described in the QA/QC plan available on-site. Adjustments are not to be made during the calibration error test. When adjustments are made following a calibration test, another calibration error test is required after all adjustments are completed to validate that the adjustment was appropriate.

The Daily Calibration Summary form included in Appendix A can be used to compile the daily calibration check data while on-site. You should also request a printout from the source's DAHS and compare these values to the values you recorded from the analyzer's display. For each monitor:

- Record the gas monitor responses from the zero and upscale calibration gas injections (for dilution systems multiply the monitor data by the dilution ratio to obtain the actual concentration).

- For flow monitors record the results of the electronic tests for ultrasonic and thermal flow monitors, or the pressure transducer checks for differential pressure monitors.

- Note the start and stop times, and whether the response is stable when the system records the calibration test response. Also check that the time taken for the test still provides at least two valid CEMS data points per hour to meet the valid hour requirements of Part 75.

- Check that the calibration gas flow rates and pressure match sampling conditions.

- Calculate the results from the monitor data and retrieve the daily calibration error (CE) results from the daily report generated by the DAHS. Compare your results to those generated by the DAHS. If there is a discrepancy ask about correction factors in the DAHS, such as pressure correction factors for dilution probes or similar factors.

- Compare the calibration error at the zero and high levels to the Part 75 data validation requirements in Appendix B, § 2.1.4(a) (see Table 4-2).

If the calibration error check is failed, the data from the monitor are invalid and the monitor is out of control until it successfully passes a subsequent calibration error test. Missing data routines must be used until the monitor is adjusted and successfully passes a subsequent calibration error test.

Table 4-2:
Part 75 Calibration Error Test Data Validation Requirements

Monitored Parameter	Calibration Error Requirement (App. B, § 2.1.4(a))
SO_2 or NO_x	≤ 5.0% of the Span Value, or ≤ 5 ppm absolute value of the difference between the monitor response and the reference value if the span value of the monitor is less than 50 ppm, or ≤ 10 ppm absolute value of the difference between the monitor response and the reference value if the span value of the monitor is greater than 50 ppm but less than 200 ppm.
CO_2 or O_2	≤ 1.0% CO_2 or O_2
H_2O	≤ 6.0% of the Span Value. Moisture monitor systems composed of wet and dry O_2 monitors must meet the O_2 calibration error requirement of ≤ 1.0%.
Flow	≤ 6.0% of the span value, or ≤ 0.02 inches of water absolute value of the difference between the monitor response and the reference value if the monitor is a differential pressure type.

You should also compare the CE results you obtain to the results of the most recent automatic calibration error test that occurred earlier in the day of your audit or on previous days. Previous calibration error tests usually can be brought up on the DAHS visual display screen. If there is a significant shift in the CE results from that previous test, ask the facility contact if they can explain the shift. Were adjustments made to the monitoring system(s) that could cause the shift? Does the shift indicate that adjustments are necessary?

Routine adjustments of the monitor are allowed after successful calibration error tests. These adjustments are to be made to bring the monitor as close as practicable to the calibration gas tag value or flow reference signal. If the monitor is physically adjusted by a person, a follow-up calibration error test is required to verify that the adjustment was performed properly. No follow-up calibration error testing is required when only a mathematical adjustment is made automatically by the DAHS. These mathematical adjustments are similar to an internal bias adjustment factor in that the DAHS evaluates the response in comparison to the reference value and assigns from that time forward an adjustment factor which is used to adjust the data for reporting. If this type of adjustment is used, the inspector should determine at what point the source physically adjusts the calibration of the analyzer (i.e., what the range of acceptable calibration error adjustment factors is). Typically, sources that use the auto adjustment in this manner physically recalibrate when the mathematical adjustment exceeds 2.5 percent of the span. The criteria that are used should be documented in the source's QA/QC plan.

4.3 Probe/Sensors, Sample Lines, and Sample Conditioning Systems

Most of the suggested checks of the probe/sensors and the sample lines do not require a visual check of the actual probe/sensors or lines. The probe/sensors and sample lines may not be easily accessible and may be located in a confined space that your agency's (or the plant's) safety policies prohibit you from entering. Access to the gas sampling probe and flow monitor probe/sensors also may require climbing ladders or working at substantial heights.

4.3.1 Probe/Sensors

You should ensure that the probe/sensors are in the same location as when the unit was certified/recertified (as detailed in the monitoring plan) -- changes in probe/sensors orientation or location require recertification of a CEMS. A hardcopy submittal of the monitoring plan will contain a diagram with the probe/sensors location. A copy should have been submitted to the State agency. If it is not available in your files, it should be on file at the plant. In addition, ask how frequently the probe/sensors are inspected, if there have been any problems (plugging for example), and if the probe/sensors or a component have been recently changed. The change might also require recertification or diagnostic testing.

Flow Monitors

In addition, for flow monitors, you could ask the source representative to perform a daily interference check as required by App. B § 2.1.2, or review the results of the most recent interference tests. The daily interference check tests the flow monitor probe or sensors, sample lines, and temperature transceiver for plugging or malfunctioning.

The interference test procedure should be identified in the QA/QC Plan. Go over the interference test procedures with the source representative, and ask if there have been any recent failures, and what corrective action was taken. Some interference checks for various types of flow monitors are described below:

- Differential Pressure - Regular back purge of probe and sample lines. Back purge flow or measured flow is monitored and compared to baseline values to indicate if there is a plugging problem. There may also be a moisture removal system, or a heated sample line.

- Ultrasonic - Purge air blowers may be installed to prevent particulate build up on the transceivers, and purge air flow rate is monitored. Units without purge air blowers can monitor signal strength to identify particulate build up.

- Thermal - Temperature sensors may have an auto self clean feature which heat the sensors to burn off particulate build-up and help avoid moisture condensation. Another approach uses short high pressure blasts of air. Interference can be tested by checking the stack temperature measured by both sensors, or by comparing the sensor measurements against calibration data.

Table 4-3:
Probe/Sensor Check Summary

What to Check	Description
All Probe/Sensor Types	
Is the probe in the same stack or duct location as in the monitoring plan?	Visually compare probe location to location on the diagram submitted with the monitoring plan. A measurement of distances from disturbances or stack/duct diameter are not necessary.
Has the duct or stack location been modified? (Dimensions)	Ask the source representative, and note during a check of CEMS maintenance logs. These duct/stack changes could affect CEMS measurements, and may require recertification.
How often are the probes/sensors inspected, have there been problems, and have the probe/sensors or components been changed?	Ask the source and note during a check of CEMS QA/QC Plan and maintenance logs.
Flow Monitors	
Ask the source to perform a daily interference check, or review the results of the most recent interference check.	Appendix B § 2.1.2 requires a daily interference check for flow monitors. Each flow monitor is to be designed to provide a means for checking interference from plugging of each sample line and sensing port, and malfunction of each resistance temperature detector (RTD), transceiver or equivalent.

4.3.2 Sample Lines

Extractive Gas CEMS Sample Lines

The daily calibration error test (see Section 4.2) provides the best check on whether gas sample line leaks are diluting the sample gas measured by the analyzer. The daily calibration error test should also detect most problems from condensation. However, for source level extractive NO_x systems that do not have an SO_2 analyzer, if practical, you should also visually check the umbilical line as it enters the CEM shelter. Look for loops or sags in the line, as well as moisture droplets. Because calibration gases do not have significant amounts of NO_2, the daily calibration error test for a NO_x monitor may not detect a negative bias from absorption of NO_2 by condensed water.

Differential Pressure Flow CEMS Sample Lines

Manual or automatic quarterly leak checks are required for differential pressure flow monitors (Appendix B § 2.2.2). The test criteria are not specified by Part 75. Most often the test checks the line after the probe flange, by closing the line and holding a steady pressure for a specified time. Check how and when the tests were performed. The test date and results (pass/fail) are reported in the EDRs, so you can confirm the reported electronic results with on-site data. If a recent test failed, find out what was done to correct the problem. A failed leak test results in out of control data until the leak is fixed and a subsequent leak check is passed (Appendix B § 2.2.3(g)).

4.3.3 Dilution Air and Gas Sample Conditioning Systems

The majority of Part 75 gas CEMS are extractive systems that transport the stack gas from the stack to an analyzer. The checks described in the next two sections relate to the systems that condition the stack gas for analysis.

4.3.3.1 Dilution Extractive Systems

Dilution systems are frequently used for Part 75 compliance. These systems dilute the stack gas with clean dry air prior to the analyzer. The ratio of sample taken from the stack to dilution air is the dilution ratio and is an important parameter of a dilution system. How that ratio is maintained, or what mathematical compensations are made to account for changes in the ratio, is important to cover during an audit.

Dilution Air Ratio

The following questions may be useful for auditing dilution extractive CEMS systems:

- What is the dilution ratio and how is it verified? This should be described in the QA/QC plan.

- Is the dilution probe ejector pump vacuum at or below the certification value? The ejector vacuum affects sample flow if it decreases below the values which creates critical flow through the orifice. How often does the source check the ejector vacuum, as well as the dilution air and analyzer flow settings? Some systems automatically adjust the dilution air pressure from a pressure transducer signal, so ask how this works. Again, these activities should be described in the QA/QC plan.

- Check if any corrections are applied to the dilution ratio for changes in pressure, temperature, or molecular weight (See Section 2.3.3.1 on gas density effects). These corrections are typically applied by the DAHS, and should be described in the QA/QC plan. Also find out if there have been any changes in the factors since the last RATA because a RATA is required following a change in these factors.

- You should also ask the source if the dilution probe orifice has been changed. The orifice controls the sample flow rate; if the orifice has changed it may have changed the dilution ratio. You can also check this during the maintenance record reviews.

- If the orifice has been changed, ask the source if there is a procedure for doing this in the QA/QC plan. In addition, ask what prompts making a change. Replacing a dilution probe orifice with one of the same size requires diagnostic testing, while replacement by a different sized orifice requires recertification. Check to see that the appropriate testing has been completed.

Dilution Air Cleaning System

The dilution air supplied to the dilution probe must be treated to remove contaminants that could interfere with the analyzers. The dilution air cleaning system removes moisture, CO_2, particulate matter, hydrocarbons, and other contaminants that may be present in ambient air. A good place to start is simply to ask the source representative how the system works. You should also investigate maintenance practices. For the air cleaning system, ask the source how often the filters are changed, and at what point drying agents are replaced. Again, this should be verified against the QA/QC plan documentation. You can also ask to see a copy of the filter replacement documentation in either the maintenance log or a copy of the daily checklist. You can check the inlet and outlet pressures of the CO_2 filter and compare to the appropriate range for the inlet and outlet pressure in the QA/QC plan. Find out from the source how often these pressures are checked and how these checks are documented.

Table 4-4:
Summary of Dilution Air System Checks

<table>
<tr><th>What to Check</th><th>Description</th></tr>
<tr><td>Has the dilution probe orifice been changed?</td><td>• The orifice controls the sample flow rate, so a change in the orifice will affect the dilution air ratio. Ask the source CEMS operator if the orifice has been changed since the last RATA, and note maintenance records for any evidence of changes (Section 4.7).
• If the orifice has been changed ask if there is a procedure for changing the orifice in the QA/QC Plan, what prompts a change, and how is the dilution ratio verified.
• If it has been changed, confirm that necessary diagnostic/recertification testing was performed.</td></tr>
<tr><td>Is the dilution probe ejector pump vacuum at or below the certification value?</td><td rowspan="2">• Ask the CEMS operator how often they check the ejector vacuum, as well as the dilution air and analyzer flow settings, and ask whether the values are recorded, and what are the proper settings.
• Also ask the operator to show that the pressure gauges or rotameters are set in accordance with the QA/QC plan, and ask how often the values are verified and documented.</td></tr>
<tr><td>Are the dilution ratio, and dilution air and analyzer flow settings properly set?</td></tr>
<tr><td>Are correction factors applied to the dilution ratio for changes in pressure, temperature, or molecular weight? Have these been changed since the last RATA?</td><td>• Some systems apply correction factors to the dilution ratio to account for changes in gas density. Changes to the correction factors should be recorded in the maintenance log, and the QA/QC plan should outline the procedures for changing the correction factors. A RATA should be performed following any change.</td></tr>
</table>

(cont.)

Table 4-4:
Summary of Dilution Air System Checks (cont.)

What to Check	Description
Check the inlet and outlet pressures of CO_2 air cleaner filter.	• Ask the CEMS operator how often they check the CO_2 air cleaner filter inlet and outlet pressures, if the values are recorded, and the proper setting. • Also ask how often the filters are changed, and at what point drying agents are replaced. Again this should be verified against the QA/QC plan documentation.
Check CO_2 air cleaner.	

4.3.3.2 Source Level Extractive Systems

Source level extractive systems transport the stack gas to the analyzer without dilution. These systems also are described as direct extractive or non-dilution systems. These systems may measure emissions on either a wet or dry basis. Wet systems need to maintain the extracted sample at a temperature above the dew point of the sample to avoid condensation in the umbilical lines. Therefore, each component of the sampling and analysis system in a wet extractive system must be heated. Dry systems require some sort of moisture removal, either through condensation or permeation driers, as well as heating of the components upstream of the moisture removal system. The daily calibration error test may show problems related with the conditioning system (except for NO_x systems as noted in Section 4.3.2).

In addition to observing a daily calibration error test, ask the source representative to describe what maintenance is performed on the conditioning system, and check that information against the maintenance log and QA/QC plan. You can also check the chiller temperature, if water is removed by condensation, and compare the temperature to the acceptable ranges in the QA/QC plan. These system checks are summarized in Table 4-5.

Table 4-5:
Summary of Source Level Extractive System Checks

What to Check	Description
Observe a daily calibration error test.	Ask the source to perform a test. This can be initiated by the source representative from the analyzer or DAHS. (See Section 4.2)
Check the umbilical lines entering the CEM shelter for condensation.	Visual check as described earlier in Section 4.3.2. Are there water droplets visible in the line?
For a dry system using chillers check the chiller temperature.	Ask the CEMS operator what the proper temperature range is, and how often it is verified. Compare against the QA/QC plan.
Check general conditioning system maintenance practices.	Ask the source representative how the conditioning system is maintained. Compare to the QA/QC plan, and check the maintenance records.

4.4 Gas Analyzers

Analyzers for extractive systems often are located in a CEM shelter and generally will be rack-mounted and connected to the conditioning system, usually with a sample manifold. In-situ analyzers are located on the stack or duct or in the annulus between the stack and stack liner.

Reminder - MDC Monitoring Plan Report

A printout of the MDC monitoring plan report can be used as a convenient check off sheet when verifying the serial numbers of CEMS components.

In checking the analyzers, it is important that you first verify that each analyzer in use is the same as the one that was previously certified or recertified. Analyzers may have been changed without the notification and recertification required by Part 75 (Subpart C, § 75.20(b)). As noted in previous sections, it is important that the source certifies the equipment actually in use.

Analyzer Displays/Alarms

Displays and alarms will vary by analyzer model. You should ask the plant contact what displays and alarms are in the model that the source uses, and what they indicate. The displays should show that the analyzer is operating properly. An alarm light may show a potential or developing problem which should be addressed as described in the QA/QC plan. Ask the source when an alarm last occurred and what caused the alarm. This information should be recorded in the maintenance log.

Flow Rate

Check the sample flow rate to each analyzer. It may be displayed digitally or by a rotameter. The proper flow rates should be identified in the QA/QC plan.

Range Settings

Ask the source what the range settings are for each analyzer and how these settings are displayed. Compare the settings to the monitoring plan (RT 530, Column 49). You should also check to see if the source has conducted an annual span/range check as required by Part 75, Appendix A, § 2.1. The range may need to be changed if that setting is not representative of the concentrations being measured or if the stack concentrations have changed (such as a change in fuel supply or new control equipment). The rule requires that the evaluation of the MPC, MEC, span and range for each gas monitor be conducted at least once a year.

Span versus Range Under Part 75

- The span is the calculated, quality-assured portion of a monitor's measurement range.
- The span is equal to 1.0 to 1.25 times the Maximum Potential Concentration (MPC) or Maximum Potential Stack Gas Flow Rate (MPF).
- The range is the actual setting of the monitor.
- The range is to be set so that the majority of readings fall between 20% to 80% of the range selected.

Range is always ≥ Span

Correction Factors

A correction factor may be applied to NO_x analyzer data to account for NO_x quenching effects. Corrections may also be applied to moisture monitors. The correction is applied to the analyzer data by the DAHS. You should ask if there have been any correction factor changes since the last RATA. Any change should be recorded in the maintenance record, and the procedures for making the change in the QA/QC plan. Verify that a RATA has been performed following the change (see § 75.20(b)).

Table 4-6:
Summary of Analyzer Checks

What to Check	Description
Have analyzers been changed without the notification and recertification required by Part 75? (Subpart C, § 75.20(b))	Ask the source if there have been any changes since the last audit or certification/recertification. Document the serial numbers and compare to those in the monitoring plan.
Status of the control panel lights, indicators and alarms? Displays should show that the analyzer is on and operating properly.	The displays will vary by analyzer, so ask the source what the displays are and what they mean. An alarm light could indicate a potential problem that needs to be addressed (check QA/QC plan).
Check range setting, and whether the source has performed the annual span/range check required by Appendix A, § 2.1.	Ask the operator what the range settings are and how they are displayed. Compare the range setting to the value in the monitoring plan (RT 530), and the results of the recent span/range check.
Check the sample flow rate.	Compare the sample flow rate if displayed by a rotameter or a digital reading to the QA/QC plan.
Have there been any changes to correction factors (NO_x quenching and moisture monitors) since the last RATA?	Changes to the correction factors should be recorded in the maintenance log, and the QA/QC plan should outline the procedures for changing the correction factors. A RATA should be performed following any change. QA testing may also be required (see § 75.20(b)).

4.5 Calibration Gases

Calibration gas cylinders are used for daily zero and span calibrations and/or linearity checks. You should spot check a number of the calibration gases to verify that the gases in use meet protocol gas requirements in Part 75, that the calibration gas concentrations meet Part 75 quality assurance test requirements, and that the values are entered correctly in the DAHS. You also can visually check the delivery system.

Make a note of the cylinder gas numbers (an engraved ID number stamped on the cylinder) and check the gas certificate for each ID number for the following information (the certificate should be on the cylinder, on file electronically, or in hardcopy at the facility):

Meets Calibration Gas Certification Requirements

- Expiration Date. Cylinder gases are not certified after the expiration date. The use of an expired cylinder is not in compliance with § 75.21(c).

- Check the type of gas certification. Part 75 requires the use of a calibration gas as defined in § 72.2; Table 4-7, below, describes the types of permissible Part 75 calibration gases.

Meets Gas Concentration Requirements

- Check that the zero air calibration gas concentrations are certified by the supplier to meet the concentration limits in § 72.2. (See Table 4-7.) Zero air material is a calibration gas that may be used to zero an SO_2, NO_x or CO_2 analyzer. Zero air material has an effective concentration of 0.0% for the component being zeroed (SO_2, NO_x and Total Hydrocarbons $\leq$ 0.1 ppm, CO $\leq$ 1 ppm, or CO_2 $\leq$ 400 ppm), and is free of certain other interfering gaseous species. A zero air cylinder containing a multi-component mixture should be certified that it meets the concentrations above, and that other components do not interfere with the CEMS reading. For more on zero air calibration gas or zero air materials, see Questions 10.2 and 10.3 in the Parts 75 and 76 Policy Manual.

- Determine the cylinder gas concentration values and verify that the values are in the correct range for the instrument span. You also should record the concentrations to make sure the values are consistent with the values entered into the DAHS for daily calibration error and linearity tests. The ranges for the low, medium and high linearity points are:

  -- Low level: 20% - 30% of span
  -- Mid level: 50% - 60% of span
  -- High level: 80% - 100% of span

Table 4-7:
Part 75 Calibration Gases (Appendix A, § 5.1)

Calibration Gas Type	Acronym	Description
NIST - standard reference material	SRM	Calibration gas obtained from the National Institute of Standards and Technology (NIST).
NIST - standard reference material-equivalent compressed gas primary reference material	PRM	Gas mixtures listed in a declaration of equivalence in accordance with section 2.1.2 of the "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards," September 1997, EPA-600/R-97/121 (EPA Traceability Protocol).
NIST - traceable reference material	NTRM	Calibration gas mixture tested by and certified by NIST to have a certain specified concentration of gases.
NIST/EPA-approved certified reference materials	CRM	Calibration gas mixture that has been approved by EPA and NIST as having specific known chemical or physical property values, certified by a technically valid procedure as evidenced by a certificate or other documentation issued by a certifying standard-setting body.
Gas manufacturer's intermediate standard	GMIS	Compressed gas calibration standard that has been assayed and certified by direct comparison to an SRM, an SRM-equivalent PRM, a CRM, or a NTRM, in accordance with section 2.1.2.1 of the EPA Traceability Protocol.
EPA protocol gas	--	Vendor-certified to be within 2.0 percent of the concentration specified on the cylinder label (tag value), using the uncertainty calculation procedure in section 2.1.8 of the EPA Traceability Protocol.
Zero air material	--	Calibration gas certified by gas vendor: SO_2, NO_x and Total Hydrocarbons $\leq$ 0.1 ppm, CO $\leq$ 1 ppm, or CO_2 $\leq$ 400 ppm. If a mixture, the other components are certified not to interfere with the CEM readings for the target compound.
Research gas mixture	RGM	Calibration gas mixture developed by agreement of a requestor and NIST that NIST analyzes and certifies as "NIST traceable."

In addition to the certificates, you should also check the calibration gas line pressure gauges to determine the cylinder gas pressure. The cylinder should not be used if the cylinder gas pressure is below 150 psi. (This requirement is in the EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards, § 2.1.6.4.) You should check to see if the facility checks cylinder pressure as part of its QA/QC plan. At what point do they replace a calibration standard? Also check the outlet regulator pressure or calibration gas flow rate to see if it matches the QA test procedures in the QA/QC plan.

Table 4-8:
Summary of Calibration Gas Checks

What to Check	Description
Check the certificates for the expiration date of the cylinder gas.	Gas cylinders may have expired dates. Cylinder gases are not certified after expiration date, and the use of an expired cylinders is not in compliance with § 75.21(c).
Check the calibration gas type (certified, EPA Protocol, or other).	Gas certifications must meet the definitions in §72.2. Check the type of cylinder gas against the descriptions in Table 4-7 and § 72.2.
Check the zero air material documentation to ensure that it is properly certified.	Calibration gas used to zero a gas analyzer. See Table 4-7 for the zero air material concentrations defined in § 72.2. (Also see Policy Manual questions 10.2 and 10.3.)
Check the concentration values for each cylinder, and that the cylinder calibration tags are withing the correct concentration range for the span.	Linearity test point ranges are shown below: Low level: 20% - 30% of span Mid level: 50% - 60% of span High level: 80% - 100% of span
Record the concentration values to check against the values recorded by the DAHS for calibration error and linearity tests.	This check is to ensure that the proper cylinder gas concentration values have been entered into the DAHS for calculation of daily calibration error tests.
Read the cylinder regulator pressure.	The cylinder should not be used if the cylinder gas pressure is below 150 psi (EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards § 2.1.6.4).
Check the regulator outlet pressure.	The pressure or calibration gas flow rate should be set as specified in the QA test procedures in the QA/QC plan.

4.6 Flow Monitors

In addition to the daily calibration error tests (Section 4.2) and daily interference tests (Section 4.3.1), there are a number of other flow monitor issues you can investigate.

Flow-to-Load

There is no equivalent to a linearity test for a flow CEMS. In response, EPA developed a quarterly comparison of flow CEMS data to unit load data. Each quarter, the source must conduct a comparison of the hourly flow and load data for any hour in which the unit load is within ± 10 of the average load during the most recent RATA. As part of your pre-audit checks, you should note whether the source conducted this test as required and whether the test was passed. If there are issues with the test conducted at the facility, go over those issues with the source representative while on site.

Temperature/Pressure Monitoring

Check to see if there are monitors for stack temperature and/or stack absolute pressure associated with the flow monitor. Ask the source what type of QA/QC procedures are followed for these monitors (what is checked and on what schedule), and if there have been any problems with these components. You can compare to the QA/QC plan or maintenance records.

K-factors

A k-factor refers to a correction factor or polynomial coefficient used by the DAHS to correct the flow monitor measurement for flow variables not measured by the monitoring method, as well as for measured changes in stack pressure and temperature. The factors are set based on a "pre-RATA" test, in which the source correlates the monitor measurement to the RATA flow reference method results.

Changing the k-factors or polynomial coefficients does not require recertification, but does require that a three load RATA be performed (§ 75.20(b)) as a diagnostic test event. You should ask when the last time the correction factors were changed and why, and check that the RATA was performed. The changes should be recorded in the maintenance log, and a procedure outlined in the QA/QC plan.

Displays/Alarms

As in the case of gas analyzers, the displays and alarms will vary by manufacturer. You should ask the plant contact what displays and alarms are in the model that the source uses, and what they indicate. Information on alarms and corrective action should be recorded in the maintenance log.

Span/Range

Ask the source what the range settings are for the flow monitor and how these settings are displayed. Compare the settings to the monitoring plan (RT 530, Column 49). You should also check to see if the source has conducted an annual span/range check as required by Part 75, Appendix A, § 2.1. (See the span/range discussion in Section 4.4.)

Table 4-9:
Summary of Flow Monitor Checks

What to Check	Description
Observe and/or review daily calibration error test and interference test.	See Sections 4.2 and 4.3.1.
Review any issues observed in reported results of flow-to-load tests.	See Appendix B § 2.2.5 for requirements of flow-to-load tests. Make sure the test was performed, and that the results were properly calculated. If the source is excluding hours from the analysis as allowed for in Appendix B, check to see that the exclusions meet Part 75 criteria.
Identify if temperature and stack pressure are monitored and what QA/QC procedures apply.	Temperature and pressure may be monitored in conjunction with the flow monitor. Note the QA and preventive maintenance procedures and schedule. Ask if there have been any problems, and corrective actions. Check the QA/QC plan and maintenance records.
Check if there have been any changes to k-factors and polynomial coefficients since the last RATA.	Changes to the correction factors should be recorded in the maintenance log, and the procedures for changing the correction factor outlined in the QA/QC plan. A three load RATA is required following any change to flow monitor k-factors (§ 75.20(b)).
Status of the control panel lights, indicators and alarms? Displays should show that the analyzer is on and operating properly.	The displays will vary by analyzer, so ask the source what the displays are and what they mean. An alarm light could indicate a potential or developing problem that needs to be addressed (check the QA/QC plan).
Check range setting, and whether the source has performed the annual span/range check required by Appendix A, § 2.1.	Ask the operator what the range settings are and how they are displayed. Compare the range setting to the value in the monitoring plan (RT 530), and the results of the recent span/range check.

4.7 DAHS

The data acquisition and handling system (DAHS) consists of all the hardware and software used to comply with Part 75 electronic recordkeeping and reporting requirements. It is a critical component of the monitoring system, as it converts the analyzer signal to reported emissions data. The on-site audit of the DAHS focuses on data handling issues that can not be checked electronically. These checks fall into three areas:

- DAHS certification and verification of missing data routines and emission calculations
- Changes in correction factors
- Manually entered data

4.7.1 DAHS Certification and Verification Tests

As for other components of the plant's CEMS, make sure that the DAHS version in use has been previously certified/recertified by checking against the monitoring plan report you printed out from MDC.

Also you should ask to see a copy of the DAHS missing data and formula verification test results. Part 75 requires a verification test for the missing data routines and emission calculation formulas as part of the initial certification (§ 75.20(c)(9)), and whenever the DAHS is replaced, upgraded to support a new EDR version, or when the missing data algorithm has been changed (diagnostic testing under § 75.63(a)(2)(iii)).

The source is not required to submit the results of the verification tests, and there are no MDC or ETS electronic checks of the routines. The source is, however, required to keep these test results on-site and available for inspection, so you should note that the tests have been performed, and what the results were (including any vendor certification). The missing data routines may be verified either by performing tests using a checking software, or by a certification by the DAHS software developer that the software package meets all of the missing data requirements of Part 75. Question 14.96 in the Parts 75 and 76 Policy Manual provides more information on the verification testing requirements.

4.7.2 Changes in Correction Factors

Previous sections on dilution extractive systems, analyzers, and flow monitors recommended that you investigate what types of correction factors, if any, are applied to raw data (e.g., pressure/temperature compensation, molecular weight, flow and moisture monitoring polynomials, sonic velocity correction factors, NO_x quenching correction factors, and dilution ratio settings). In addition you should ask how changes to these correction factors are entered into the DAHS. As noted earlier, changes to correction factors should be recorded in the maintenance log, and the QA/QC plan should outline the procedures for changing the correction factors (Appendix B, § 1.1.3). Diagnostic QA testing is required for many of these changes (see § 75.20(b)).

4.7.3 Manually Entered Data

Part 75 requires that the DAHS automatically record all emissions data and the daily calibration error checks (Appendix A, § 4). There are a few exceptions which allow manual entry or editing of data, which are shown in the text box. Check how various types of data are entered manually by asking the source to explain their procedures, and by reviewing the QA/QC plan and the hardcopy supporting

Manual Data Entry Allowed by Part 75

- Negative (< 0) emission values
- Erroneous emission values (if significant must be approved by EPA)
- SO_2 concentration < 2.0 ppm
- Reference method back-up data
- RATA reference method data and RATA results
- Leak checks, 7-day calibration error tests, and cycle time tests
- Operating data (load and time)
- Missing data periods
- Add-on control equipment operation during missing data periods

For more information on manual entry or editing, see Section II.C.3 of the EDR v2.2 Reporting Instructions (August 2002).

information for the manually entered data. A number of areas you may emphasize are described below.

QA Tests

Ask the source how the QA test results (daily calibration error test, linearity test, and RATAs) are entered into the DAHS. If you have not compared a RATA report from the MDC program to plant hardcopy RATA results in your pre-audit review, ask for a hardcopy of the report and check that the dates and time, relative accuracy, and bias adjustment factors (BAF) match. Also if you identified problems with QA test calculations, go over how that data are entered into the DAHS, as well as the applicable QA/QC plan procedures. For example, the BAF may not have been applied correctly to the emission data. The BAF should be applied starting with the hour following completion of the RATA.

Missing Data

Ask how the source records and reviews missing data. How do they check that the substitute values appear correct (e.g., do the substituted values appear to be correct in view of the percent monitor data availability (PMA) and the length of the missing data period; do the substitute NO_x and flow rate values change when the load range changes during a missing data period; are maximum potential values substituted when the PMA drops below 80.0 percent)? Compare the procedures described to those in the QA/QC plan. Pick out a recent missing data period (one you may have identified in your pre-audit review), and spot check the electronic data by comparing against supporting hardcopy documentation.

Optional Missing Data Routines - Units with Add-on Control Equipment

If the source is using an *optional* missing data routine for units with add-on control equipment, you also may need to review control device parameter monitoring records. There are four missing data options for units with add-on controls, three of which require parameter monitoring to demonstrate the level of control achieved during the missing data period (§ 75.34).

§ 75.34, Optional Missing Data Procedures for Units with Add-On Control Equipment

(1) Standard Missing Data Routines with Parametric Supporting Data
(2) No Parameter Data
(3) Parametric Missing Data Substitution Method
(4) Parameter Data Used to Support Use of Maximum Controlled Emission Rate

You will first need to check the QA/QC plan. The facility must identify add-on SO_2 or NO_x control equipment parameters and acceptable ranges in the plan if the source is using add-on control equipment missing data options (see Part 75, Appendix B, § 1.1.1). Ask the source for the parameter monitoring records for a number of missing data periods. You may have identified specific missing data periods from your pre-audit preparation. Compare the parameter data to the acceptable ranges in the QA/QC plan and identify any periods when the parameter range is exceeded. Check how the missing data period was then flagged in the DAHS (control operating properly or not operating properly).

Table 4-10:
Summary of DAHS Checks

What to Check	Description
Check that DAHS verification tests have been performed for the missing data routines and calculations.	Check the DAHS against the monitoring plan. Verification tests for missing data routines and emissions calculations are required for initial certification and if the DAHS is replaced or there have been changes to the software. Verification test results for the missing data routines and emissions calculations are required to be kept on site by §§ 75.20(c)(9) and 75.63(a)(2)(iii). A vendor certification that the software meets Part 75 requirements is sufficient for missing data routines.
Ask the source what type of correction factors are applied to raw data, and how they are entered into the DAHS. Also ask if any changes have been made.	Changes to correction factors should be recorded in the maintenance log, and the QA/QC plan should outline the procedures for changing the correction factors (Appendix B, § 1.1.3). QA testing may also be required (see § 75.20(b)).
Ask what data are entered manually, and how. Spot check the electronic data with the manual hardcopy.	You want to make sure there is documentation supporting the data that is added manually to the DAHS, and that QA/QC plan procedures are followed. Procedures for manually entering data should be documented in the QA/QC plan.
How are data for the daily calibration, linearity, and RATA tests recorded? Review some recent records to verify that hardcopy and electronic data match.	Compare a RATA or linearity report from the MDC program to the plant hardcopy. Check that the dates and time, relative accuracy (or linearity error), and bias adjustment factors (BAF), if applicable, match.
Review parameter monitoring records for units using the optional missing data procedures for add-on control equipment.	The QA/QC plan will identify control equipment parameters and acceptable ranges (Appendix B, § 1.1.1 and § 75.58(b)). Compare the control equipment parameters to the ranges for a missing data period.

4.8 Maintenance Log and Daily Checklists Review

The maintenance logs should detail any maintenance performed on the system and should reference all preventive maintenance performed. Appendix B, Section 1.1.3 requires the facility to keep the following maintenance records:

- Date, time, and description of any testing, adjustment, repair, replacement, or preventive maintenance action performed on any monitoring system;
- Records of any corrective actions associated with a monitor's outage period;
- Any adjustment that changes a system's ability to record and report emissions data must be recorded (e.g., changing of flow monitor or moisture monitoring system polynomial

coefficients, K factors or mathematical algorithms, changing of temperature and pressure coefficients and dilution ratio settings); and

- A written explanation of the procedures used to make the adjustment(s).

During the inspection you should begin by asking the CEMS technicians to describe what goes wrong with equipment, what breaks, and what maintenance is required. Ask how they knew something was wrong, and what they did about it. Also ask what QA tests were done to show that the problem was resolved. Make sure you understand what they are saying, as their terminology may not always match the Part 75 rule terminology. For example, the plant personnel may refer to a daily calibration error test as a "system cal," "overboard cal," or "span check."

Then check the maintenance log book to see how the information is recorded. You should point out any entries that you do not understand, and explain why you do not understand the entry. Compare to the QA/QC plan to determine whether the source is implementing the preventive maintenance procedures. You should also review the maintenance log to identify recertification events and adjustments that have been made to the systems which could affect the monitored data. The maintenance log may also provide another check on handling of missing data periods, and it can verify that linearity tests and RATAs were performed on the dates identified in the EDR.

Some checks may include:

- Do the log entries sufficiently describe the action taken? Are the entries understandable?

- Does the log show maintenance checks at the frequency identified in the QA/QC plan?

- Are there recurring failures or malfunctions recorded in the log?

- Are malfunctions resolved as specified in the QA/QC plan? Are calibration error tests or other required QA tests performed before the CEMS is returned to service?

- Do events in the maintenance log correspond to reported missing data periods in the quarterly reports?

- Are there repeated adjustments to the zero or span?

- Have system parts or components been replaced? If so, has the proper recertification or diagnostic testing been performed?

- Are corrective actions recorded for malfunctions or as a result of daily calibration error tests or other performance tests?

- Are the name/initials of the person performing task or logging data provided? (While this is not required, it is important for the log entries to be traceable to the person who makes the entry so that further questions can be answered if needed.)

4.9 QA/QC Plan Review

The QA/QC plan has been referenced throughout the previous sections. At a minimum, a QA/QC plan should describe the detailed procedures and operations for: calibration error and linearity tests; calibration and linearity adjustments; preventive maintenance and any adjustments to the system; spare parts list; a troubleshooting matrix; and recordkeeping and reporting. For units with add-on SO_2 or NO_x emission controls, the QA/QC plan may also contain (for missing data purposes) add-on emission control parameters and the range for each parameter representative of the normal operating conditions. Required elements in the QA/QC plan are summarized in Table 4-11. You should note that Part 75 allows electronic storage of the information in the QA/QC plan, provided that the information can be made available in hardcopy upon request during an audit. The plan may also reference manufacturer's operating manuals.

Reviewing QA/QC plan information is an important aspect of the on-site inspection activities described throughout the previous sections. A recommended approach to inspecting various aspects and components of a plant's CEMS QA program is to:

- Ask the plant staff to explain how they operate the equipment and perform QA and maintenance activities.

- Observe and record your own observations of procedures, plant documentation, and equipment settings.

- Compare the QA/QC plan description of the equipment settings, monitoring operating procedures, and QA test procedures to actual operations at the plant.

You should note instances where actual plant operations are different from the operations described in the QA/QC plan, and ask for an explanation. Determine and discuss whether the actual procedure or the QA plan procedures meet Part 75 requirements. In some cases the actual operations may be appropriate, but the QA/QC plan may need to be updated. Clearly, you should also note areas where the actual operations and QA/QC plan match, but neither meet Part 75 requirements.

In addition to examining specific elements of the QA/QC plan where there are discrepancies or potential problems you may also do a general review of the QA/QC plan to check that the plan covers the Part 75 elements as shown in Table 4-11. Particular areas to focus on are the QA test procedures, CEMS adjustment procedures, and preventive maintenance procedures.

Table 4-11:
Checks for QA/QC Plan Elements

What to Check	Part 75 Requirement
Is there a written QA/QC plan (it may be stored electronically but should be available), and when was it last updated?	Appendix B, § 1
Are calibration error test and linearity test procedures outlined in the plan?	Appendix B, § 1.2.1
Are calibration and linearity test adjustment procedures outlined?	Appendix B, § 1.2.2
Are RATA test procedures provided?	Appendix B, § 1.2.3
Are emissions and QA test recordkeeping and reporting procedures, including missing data procedures included?	Appendix B, § 1.1.2
If using add-on control equipment missing data options, are control equipment parameters identified?	Appendix B, § 1.1.1
Are procedures for preventive maintenance and Part 75 recordkeeping/reporting identified?	Appendix B, §§ 1.1.1 and 2

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Section 5: CEMS Performance Test Observation

Section 5 covers how you should observe CEMS performance tests (linearity tests and RATAs). You will generally observe a performance test in conjunction with the on-site CEMS audit activities outlined in Section 4.

5.1 Introduction

In addition to the basic step of observing a daily calibration error test (see Section 4.2), EPA encourages all States and Regional Offices to conduct level 2 audits that include a RATA or linearity test observation. These performance tests are a critical element of the Part 75 QA program. The RATA, in particular, serves as the primary measurement of CEMS accuracy. The presence of an agency observer can serve as an effective tool for ensuring that the source carries out the testing properly and that the results of the tests provide a valid assessment of data quality.

During the performance test observation you should document any deviations from the test protocol. You should provide copies to the source to avoid misunderstandings about any decisions you may make. The observer should notify the tester immediately if there is a question as to whether or not any test procedures comply with Part 75 requirements, so that the tester can take corrective action and, if necessary, restart the testing.

Once the performance test is started and until it is concluded, the only adjustments that may be made to the monitor are routine calibration adjustments towards the calibration gas or reference signal value that are the result of a regularly scheduled calibration error test. This is more likely to occur during a RATA than during a linearity test.

The source can make non-routine calibration adjustments (done by physically adjusting the instrument response using analyzer controls) before the linearity or RATA, and at other times, provided the QA/QC plan includes specific criteria for the adjustment. A calibration error test must be performed following the adjustment (Part 75, Appendix B, § 2.1.3). You should note if any adjustments were made prior to the performance test, and review plant maintenance records for documentation of the adjustment (Part 75, Appendix B, § 1.1.3).

Calibration error tests are often performed prior to a linearity test or RATA. As discussed earlier with respect to monitor adjustments, you should ask the source if a calibration error test was performed prior to the linearity or RATA to be observed, what the results were, and if any adjustments were made. RATA and linearity tests should not be conducted on a system that is out-of-control with respect to the calibration error requirements.

Appendix A contains observer checklists to assist you in observing the performance tests. You should also be familiar with the Part 75 performance test requirements in Appendix A §§ 6.2 and 6.5, and the Part 60 reference methods used in the RATAs.

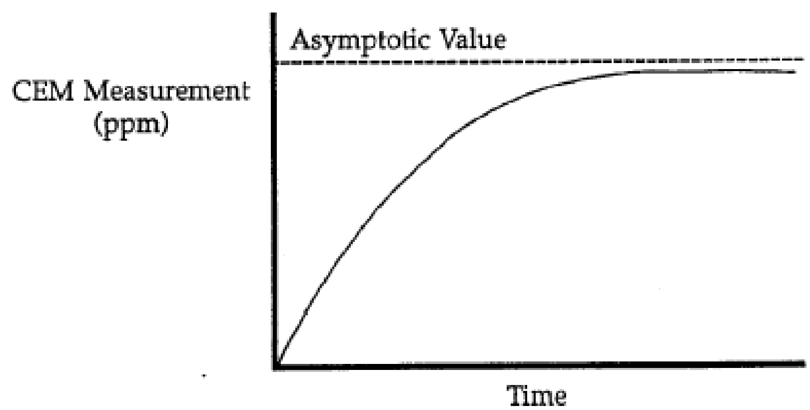
5.2 Linearity Test

A linearity test for a gas CEMS is conducted by challenging the CEMS with three audit gases: one having a value of 20 to 30 percent a monitor's span, the second a value of 50 to 60 percent of span, and the third a value of 80 to 100 percent of span. Flow and moisture monitors are not subject to the linearity test requirements, and SO_2 and NO_x monitors with spans ≤ 30 ppm also are exempt. The source must conduct a linearity test every quarter (although exceptions for low operating hours and grace periods may apply). For a dual range analyzer, the test is performed for each range used during the applicable quarter.

The CEM system is challenged three times with each audit gas. The same gas concentration or level is not to be run twice in succession. The audit gas is injected at the gas injection port required in Part 75, Appendix A, § 2.2.1.

The response to the zero and upscale gases is not immediate, but approaches an asymptotic value (See Illustration 5-1). It is important that sufficient time is allowed for the concentration reading to stabilize for each injection of gas. Watch the analyzer's instantaneous response to see if enough time is allowed to reach a stable fully equilibrated response. The time should not exceed 15 minutes. Pay the most attention to SO_2, since it is the most adsorptive and absorptive (this will delay the equilibration time).

Illustration 5-1:
Asymptotic Calibration Check Response (Jahnke, 1994)



Also note the time required compared to the gas injections for the daily calibration error tests. Both times should be about the same. If they are not ask the source why this is the case. Record the analyzer's stabilized response and compare to the value recorded by the DAHS. The values should be the same. The average CEMS response will be taken from the DAHS as the official component for recording the CEMS data. These linearity test procedures and requirements are specified in detail in Part 75, Appendix A, § 6.2.

Time Shared Systems

Time shared systems use the same gas analyzers for multiple emission units. For time shared systems, the 15 minute maximum cycle time requirement for the analyzer gas concentration to stabilize includes the cycle time of each probe location served by the system.

Appendix A contains an observer checklist. Inspect the cylinder gases as outlined in Section 4, record the linearity test results using the checklist, and calculate the linearity result for each level. Compare the results to the appropriate performance specification listed in Table 5-1.

Table 5-1:
Linearity Test Specifications

Monitored Parameter	Linearity Test Performance Specification (Part 75, Appendix A, § 3.2)
SO_2 or NO_x	≤ 5.0% linearity error, or ≤ 5 ppm absolute value of the difference between the average of the monitor response values and the average of the reference values |R-A|
CO_2 or O_2	≤ 5.0% linearity error for each calibration gas concentration, or ≤ 0.5% absolute value of the difference between the average of the monitor response values and the average of the reference values |R-A|

5.3 Relative Accuracy Test Audit (RATA)

A Relative Accuracy Test Audit (RATA) compares a unit's CEMS measurements to that of reference method stack tests. The reference method tests yield results representative of the pollutant concentration, emission rate, moisture, temperature, and flue gas flow rate from the unit. The RATA compares these results directly to CEMS measurements. The RATA test is the primary measurement of CEMS accuracy for a Part 75 CEMS.

RATA Reference Materials

Reference Methods in Part 60, Appendix A, are available at the Emission Measurement Center website: www.epa.gov/ttn/emc.

Answers to common Part 75 RATA questions are provided in the Parts 75 and 76 Policy Manual at www.epa.gov/airmarkets.

Part 75 requires semi-annual or annual RATAs, depending on the relative accuracy achieved in the preceding RATA. Most units qualify for the annual RATA frequency (Appendix B, § 2.3.1.2).

Gas RATAs performed at single load levels are often conducted simultaneously, and may take about 7 hours. The flow RATAs may be conducted at one, two, or three loads. A multi-load RATA may therefore be performed over 2 to 3 days, with each load of the flow RATA taking about 3 to 5 hours. One load of the flow RATA testing often is conducted at the same time as the gas RATAs. Part 75 requires that each RATA be completed within 168 consecutive unit or stack operating hours. For multi-load flow RATAs, up to 720 consecutive unit or stack operating hours are allowed to complete the testing at all load levels (Part 75, Appendix A, § 6.5).

Flow RATAs are conducted at load levels in the range of operation that extends from the "minimum safe, stable load" to the "maximum sustainable load." Three levels apply in this range:

Low: First 30% of range **Mid:** > 30.0% and ≤60.0% **High:** > 60.0% of range

You should ensure that the source performs the RATA according to Part 75 and reference method requirements. RATA issues of specific importance to Part 75 requirements include:

- **Unit operating conditions**. The RATA should be performed while the unit is burning a normal fuel listed in the monitoring plan (App. A § 6.5(a)). **Gas RATAs** should be performed at normal load. Check the load against the monitoring plan normal load. If you have questions about the normal load identified in the plan, you may also check load against the most recent load data submitted in the EDR to verify that the current load designation is representative of the loads reported. **Flow RATAs** for peaking units or bypass stacks can always be performed at one load. For all other situations, the RATA for initial certification or recertification of a flow monitor must be a 3-load test. A 3-load flow RATA also is required at least once every 5 years as part of the ongoing QA requirements. For units that must conduct a flow RATA on an annual basis, the standard QA flow RATA is a 2-load test. For units that must conduct a flow RATA on a semi-annual basis, the source can alternate between a 1-load and a 2-load test. Finally, units that operate at 1-load consistently (at least 85 percent of the time) can qualify for 1-load testing instead of the 2-load test (see Part 75, Appendix B, § 2.3.1.3(c)).

- Check if the source conducted a **daily calibration error test** on the CEMS prior to the testing or **pre-RATA adjustments**. While Part 75 allows a source to make pre-RATA non-routine adjustments, adjustments may not be made between runs at a load level or between load levels except for routine adjustments as a result of the calibration error test (Part 75, Appendix B, § 2.1.3).

- Has the source performed and passed a **stratification test**? Stratification testing is required for units wishing to use fewer traverse points under the alternatives allowed in Part 75, Appendix A, § 6.5.6(a) and (b). For details on stratification testing, see Part 75, Appendix A, § 6.5.6.1 - 6.5.6.3.

- **Rake probes** should not be used as they do not distinctly capture the required traverse points to ensure that a representative stack sample is obtained for analysis. See Policy Manual Question 8.39.

- **Moisture measurements**, used to correct dry basis measurements in determining emission rate, may not be made using the wet bulb-dry bulb technique. Wet-bulb-dry bulb measurements, however, may be used to determine molecular weight. See Policy Manual Question 3.10.

- EPA recently promulgated new flow reference methods **(2F, 2G, and 2H)**. Part 75 sources had raised concerns that Method 2 measurements could be biased high in some situations due to stratified or non-parallel flow. In response, Method 2F measures yaw and pitch angle adjusted velocity, 2G adjusts for yaw angle, and 2H accounts for wall effects. A detailed observer checklist is available for these methods at CAMD's website, and you should refer to that observer checklist if you are observing a flow RATA using one of these new methods. Also available for downloading from the website is software (FLOW-CALC) that you can use to enter the reference method data and calculate results. See http://www.epa.gov/airmarkets/monitoring/index.html

- Check that the **traverse point locations** for the reference method tests meet the requirements of Appendix A §, 6.5.6, and the sampling location dimensions. Gas tests should typically use at least 3 traverse points. Check Performance Specification (PS) 2 in Part 60, Appendix B. Units with wet scrubbers may use a shorter measurement line than required by PS 2 if minimal stratification is demonstrated, and moisture and gas systems may use a single point if the stratification test is passed (Part 75, Appendix A, § 6.5.6). The minimum number of traverse points for **a flow test** is 12, unless also using Reference Method 2H, which requires at least 16 points (Part 60, Appendix B). A source can use more than the minimum number of sample points.

- Check the reference method **calibration gases** used for instrumental test methods. The calibration gas certificate should show: EPA Protocol gases or other certified gases; concentrations that match those used in the bias/drift check calculations; and an expiration date after the RATA. The regulator gauge should show a cylinder pressure > 150 psi.

- Verify the **relative accuracy and reference method calculations** yourself by doing the calculations on site using the raw data. You should also obtain a copy or record the results of the RATA tester's calculations. Make sure that the CEMS and reference method data are for the same runs.

Observation forms for flow and gas RATAs are provided in Appendix A. The forms have more detailed checks than provided here. In addition, as noted above, an observer checklist for flow reference methods 2F, 2G, and 2H is available at CAMD's website.

RATA Reference Methods (Part 75, Appendix A, § 6.5.10)

The following methods from Appendix A to Part 60 or their approved alternatives are the reference methods for performing relative accuracy test audits:

- Method 1 or 1A for determining the appropriate test locations;
- Method 2 or its allowable alternatives including in Appendix A to Part 60 (except for Methods 2B and 2E) for **stack gas velocity** and **volumetric flow rate**;
- Methods 3, 3A, or 3B for $\mathbf{O_2}$ or $\mathbf{CO_2}$;
- Method 4 for **moisture**;
- Methods 6, 6A, or 6C for $\mathbf{SO_2}$;
- Methods 7, 7A, 7C, 7D, or 7E for $\mathbf{NO_x}$, excluding the exception in section 5.1.2 of Method 7E. When using Method 7E for measuring NO_x concentration, total NO_x, both NO and NO_2, must be measured. Notwithstanding these requirements, Method 20 may be used as the reference method for relative accuracy test audits of NO_x monitoring systems installed on combustion turbines.

Section 6: On-Site Inspection of Appendix D and Appendix E Monitoring Systems

Section 6 focuses on the on-site review of fuel monitoring and operating records that are required for units that use the excepted monitoring provisions available to gas and oil fired units. The audit emphasis is on verifying recordkeeping.

Part 75, Appendix D provides an optional monitoring protocol that may be used by gas- or oil-fired units instead of SO_2 and flow CEMS. It includes procedures for measuring oil or gaseous fuel flow using a fuel flowmeter and procedures for conducting sampling and analysis to determine sulfur content, density, and gross calorific value (GCV) of fuel oil or gaseous fuels.

Part 75, Appendix E is available to qualifying gas or oil fired peaking units as an optional NO_x emissions rate estimation procedure that may be used instead of a NO_x CEMS. Baseline stack testing is performed at four operating levels to establish a NO_x rate - heat input curve with NO_x rate the dependent variable.

6.1 QA/QC Plan Review

The QA/QC plan provides a template for performing a review of fuel monitoring and sampling records, and is the place to start the field audit for the excepted monitoring provisions of Part 75, Appendices D and E. As described in Section 4.9, you should determine whether the QA/QC plan meets the requirements of Part 75, Appendix B, and whether the facility is implementing the plan. Checks of the QA/QC plan and rule requirements for Part 75, Appendix D are identified in Table 6-1, and the checks for Part 75, Appendix E are in Table 6-2.

Table 6-1:
Appendix D - QA/QC Plan Review

What to Check	Part 75 Requirements
Review the fuel sampling methods and analysis procedures. Compare the sampling methods and frequencies to the rule requirements outlined in the sample Appendix D field audit sheets (see Appendix A of this manual).	The QA/QC plan should include standard sampling and analysis procedures used by the source or its fuel supplier (Appendix B, § 1.3.5).
Are the fuel flow meter test procedures and the transducer or transmitter accuracy test procedures outlined in the plan? Ask the source how often (and how) the tests are performed, and compare to the plan and Part 75 requirements.	Test procedures are required in the QA/QC plan (Appendix B, § 1.3.2).

(cont.)

Table 6-1:
Appendix D - QA/QC Plan Review (cont.)

What to Check	Part 75 Requirements
Check the fuel flowmeter, transducer, or transmitter calibration and maintenance records.	Records are required by the QA/QC plan provisions in Appendix B, § 1.3.3. Those records are to include adjustments, maintenance, or repairs performed on the fuel flowmeter monitoring system as well as records of the data and results for Appendix D fuel flowmeter accuracy tests and transducer accuracy tests.

Table 6-2:
Appendix E - QA/QC Plan Review

What to Check	Part 75 Requirement (App. B § 1.3.6)
Check the recommended range of QA/QC parameters, and hourly records of these parameters. Make sure the parameters are identified and recorded.	The QA/QC plan must identify recommended ranges of quality assurance- and quality control-related operating parameters that are recorded each hour. There are to be at least 4 parameters for turbines or reciprocating engines, and oxygen for boilers. (Appendix E, § 2.3.2).
Request that the source identify any parameter deviations, and ensure proper missing data procedures are used for those hours.	The source is required to redetermine the Appendix E correlation if a single deviation period exceeds 16 operating hours
Check written Appendix E NO_x emission rate testing procedures.	This is another required component of the QA/QC plan. The procedures should match the test requirements in Appendix E, § 2.1.

6.2 DAHS and Supporting Records

Elements of the data acquisition and handling system (DAHS) for an Appendix D or Appendix E monitoring systems should be checked in a manner similar to that described under the CEMS on-site inspection in Section 4 of this manual.

The DAHS consists of all the hardware and software used to comply with all electronic recordkeeping and reporting requirements. Make sure that the version used is previously certified/recertified by checking against the monitoring plan, and ask to see and check the DAHS verification test for the missing data routines. The source is not required to submit these results, and there are no electronic checks of the routines. Verification test results for the missing data routines are required by §§ 75.20(c)(9) and 75.63(a)(2)(iii). The latest test should have occurred no earlier than when the unit began using EDR v2.1 (or v2.2, when applicable).

Additional checks are necessary to ensure that data entered manually into the DAHS match hardcopy supporting information. Fuel sampling data (sulfur content, density, GCV) may be entered manually into the DAHS. Ask the source how these data are entered. You should also compare the electronic fuel data in the DAHS to the on-site hardcopy fuel sampling and analysis data to make sure they match. The source may pull the electronic data up for you using the DAHS, or you may use data that you printed out from MDC Hourly.

You should also investigate how emissions data, missing data periods, and operating parameters are recorded. If data are entered by hand, you should similarly spot check the electronic data with the hardcopy. For Appendix E units, check to see that the results from the plant's copy of the Appendix E NO_x emission rate tests match the curve in the monitoring plan and DAHS. This should include checks on the dates and times, NO_x load, and fuel flow values. You can use MDC's Appendix E test report function to review the electronic data. You should also check the source's hardcopy capacity factor documentation against the capacity factor submitted in the EDR (see Record Type 507).

Table 6-3:
Summary of DAHS and Supporting Records Checks

What to Check	How to Check
Check that the current DAHS version is certified and that a DAHS verification test was conducted for the missing data routines.	Compare the DAHS to that identified in the monitoring plan. Missing data routine verification test results are required by §§ 75.20(c)(9) and 75.63(a)(2)(iii). The latest test should have occurred no earlier than when the unit began using EDR v2.1 (or v2.2, when applicable).
How is fuel sampling data (sulfur content, density, GCV) entered? Do the data match the fuel analysis results?	Ask the source to pull up the fuel data in the DAHS and compare to hardcopy fuel sampling and analysis data.
How are emissions data, missing data periods, and operating parameters recorded?	If the data are entered by hand, spot check the data with the hardcopy.
Does the hardcopy report of the Appendix E NO_x emission rate tests match the curve in the monitoring plan and DAHS?	Compare the plant's copy of the test report to the Appendix E test report from the MDC program. Check that dates and times, NO_x, load, and fuel flow values match.

6.3 Appendix D Fuel Flow Monitors

If practical, visually check the fuel flow monitors to verify that the fuel flow monitors match those in the monitoring plan. At a minimum, the monitoring plan should at least show the flowmeter component type, manufacturer, model/version, and serial number. Some units may also report each auxiliary component (pressure and temperature transducers and transmitters) in the monitoring plan.

6.4 Appendix D Fuel Flow Monitor Quality Assurance

Billing meters are exempt from QA accuracy testing and other quality assurance requirements (Part 75, Appendix D, § 2.1.4). You should first ask if the monitor is used for commercial billing and has been designated as such. This should be identified in the monitoring plan. If it is, no further checks are necessary.

6.4.1 QA Testing

After the initial certification tests, fuel flow monitors are to be tested once every four fuel flowmeter QA operating quarters. Extensions up to 20 operating quarters are available based on quarterly fuel flow-to-load test results. For these QA tests, make the following checks:

- **Are quarterly fuel flow-to-load tests performed?** This test is optional. Test results are reported in the EDR -- you may have reviewed the data prior to the visit using MDC. Verify that on-site test results match those in the electronic report.

- **Check fuel flow monitor accuracy test reports.** Compare the hardcopy accuracy test results against those reported electronically. MDC can provide a copy of the electronic report. You can also verify the calculations. Ask the source for a copy of the report, which should be in a format similar to Part 75, Appendix D, Table D-1 or D-2.

6.4.2 Maintenance and Inspection Records

The maintenance logs should detail any maintenance performed on the system and should reference all preventive maintenance performed. During the inspection, you should look at the maintenance log book, which is required as part of the QA/QC plan. The maintenance conducted should match the maintenance procedures in the plan. Also verify that there have been no changes to monitoring equipment without appropriate recertification testing. See Section 4.8 for more discussion of maintenance logs.

Section 7: Reporting Audit Results

Section 7 provides a brief overview of reporting results in the exit interview and audit report. The interview should highlight issues suggesting data invalidity so that the source can take steps to minimize allowance penalties from missing data. CAMD should receive prompt notice of issues that may affect the validity of mass emissions data.

7.1 Exit Interview

You should conduct an informal summary of the audit findings (exit briefing) before you leave the facility. You should discuss the audit findings with reference to specific regulatory requirements, or in terms of potential problems. Evidence should be available to support a finding or observation, although you should raise any questions on a monitoring method or rule requirement. If a source disputes a finding, you should give it an opportunity to provide adequate alternate information. Further investigation after the meeting may be required to achieve the resolution of questioned items. In such cases, you should table the discussion at the briefing.

If you perform the audit periodically, you should address any progress or lack thereof since the previous audit. This is readily done by reviewing the findings of the last audit and noting how the issues have been resolved. If there has been no progress, the review should emphasize the ongoing problems and stress the need for immediate resolution.

7.2 Audit Report

The audit report organizes and coordinates information gathered during the audit in a usable manner -- it is the compilation of factual information and professional judgment resulting from the audit. The report also serves to record the procedures used in gathering the data and gives factual observations and evaluations from the audit. Information in the report must be accurate, relevant, complete, objective, and clear. You should avoid discussions of general topics, and should link all compliance issues directly to regulatory requirements. Include any follow-up actions in the audit report.

You also should prepare a cover letter summarizing the audit results and follow-up activities. Send the cover letter and audit report to the Designated Representative or the source's contact person and a copy to the EPA Regional and/or State agencies. The Clean Air Markets Division should receive a copy of the cover letter. If any findings are likely to affect reported mass emissions used for allowance true-up activities, notify CAMD immediately. You should complete the audit report within one month following the audit, while observations are still fresh, and to provide a quick response to any problems. Notify the source if the report is delayed.

7.3 Follow-up Activities

The audit team should keep documentation of any outstanding issues from the audit. A follow-up review should be scheduled within a reasonable time after the audit.

Section 8: Conducting Level 3 Audits

Section 8 discusses issues that an agency should consider in developing a performance testing program (a Level 3 audit capability). This section emphasizes single gas challenges and linearity tests.

8.1 Overview

This section focuses on issues that an agency should consider if it chooses to develop a Level 3 audit program that includes single gas challenges and linearity testing of gas CEMS. The emphasis in this section is on the calibration gases and development of a testing program, rather than on a step-by-step description of how to perform a test.

Agencies that currently do not perform Level 3 performance tests may have in-house expertise and experience available in the agency's ambient air monitoring staff. Single gas challenges and linearity testing of Part 75 gas CEMS require the same knowledge base as calibration testing of ambient gas monitors. An agency can take advantage of this existing resource in developing a Level 3 program for Part 75 audits.

8.2 Tri-Blend or Single Blend Gases

Part 75 affected sources commonly use multi-component calibration gases. Multi-component gases provide cost savings over single component gases by reducing the number of cylinder gases and the equipment necessary for calibration tests. These calibration gases also allow for calibrating analyzers simultaneously. The tri-blend (or triple blend) contains SO_2, NO, and CO_2. The SO_2 and NO are at relatively low concentrations in the ppm range, while the CO_2 concentration is in the percent range. The single component (or single blend) calibration gas consists of the target compound -- SO_2, NO, or CO_2 -- blended with N_2 or air. Compared to a single blend, a tri-blend replaces a portion of the N_2 or air with CO_2 (up to 20 percent by volume for high range testing).

Tri-blends with a CO_2 concentration of 11 percent (representative of most stack conditions) are recommended for agency auditors. CO_2 concentrations representative of stack gas conditions will minimize molecular weight or interference effects, described below, that can occur if the CO_2 concentration in the calibration gas is different from the stack gas.

Molecular Weight of Major Calibration Gas Component Compounds

- CO_2 44
- N_2 28
- Air 29

Molecular Weight Effects - Dilution Systems

CO_2 weighs more than N_2 or air, so a tri-blend calibration gas containing CO_2 will be heavier than a single blend calibration gas in which the balance is either N_2 or air. This will impact a single gas challenge or linearity test of dilution extractive systems if the inspector uses a single blend to conduct a test on units that normally use tri-blends for calibration and quality assurance. The sample flow in a dilution extractive system is controlled by the critical orifice, which is dependent on molecular weight. Dilution extractive systems, therefore, will produce different test results depending on whether a single blend or tri-blend gas is used. Your best approach to dealing with this issue is to use a tri-blend with CO_2 concentrations representative of stack conditions. Table 8-1 summarizes the effects of calibration gas blend molecular weights on dilution system emission measurements and QA testing measurements.

Table 8-1:
Effects of Gas Blends on Dilution System Measurements
(from Table 3-2 in Jahnke, 1994)

Activity Performed	Calibration Gas Blend Used	Possible Resulting Measurement Biases
Emissions Measurements	CEM system calibrated with CO_2 triple blend	Emission measurements bias minimized (because CO_2 present in both flue gas and calibration gas).
	CEM system calibrated with single blend (e.g., SO_2 in nitrogen)	Emission measurements are biased (because CO_2 is present in flue gas).
Calibration Error Test and Linearity Check	CEM system calibrated with single blend	Calibration error test conducted with CO_2 triple blend will show a bias. Linearity check conducted with CO_2 triple blends will show bias.
	CEM system calibrated with CO_2 triple blend	Calibration error test conducted with single blend will show a bias. Linearity check conducted with single blends will show bias.
RATA	CEM system calibrated with single blend	RATA conducted with Reference Method 6C calibrated with a CO_2 triple blend will show bias.
	CEM system calibrated with CO_2 triple blend	RATA conducted with Reference Method 6C calibrated with a single blend will show bias.
	CEM system calibrated with a single blend	RATA conducted with Reference Method 6C calibrated with a single blend will minimize bias.
	CEM system calibrated with CO_2 triple blend	RATA conducted with Reference Method 6C calibrated with a CO_2 triple blend will minimize bias.

Interference Effects

CO_2 can interfere with chemiluminescent NO_X monitors ("quenching") and cause a negative error in the NO_x emission measurement. If the auditor uses a NO single blend calibration gas without CO_2, the result reported by the DAHS will be higher than the calibration gas concentration, as the CEMS results are corrected to account for the CO_2 concentration in the stack gas. As in the case of molecular weight effects, using a tri-blend with CO_2 concentrations representative of stack conditions will minimize this problem.

8.3 "Hands Off" Policy

EPA's "hands off" approach, discussed in Section 1.4.1, also applies to conducting a single gas challenge or linearity test. You do not need to physically handle a facility's CEMS hardware. You should ask qualified plant personnel to perform any actions with the CEMS equipment. This includes connecting cylinder gases to the plant calibration gas manifolds or your gas delivery line to the CEMS calibration gas injection point, and obtaining results from the DAHS.

8.4 Test Plan/Procedures

The agency should prepare standard operating procedures for performing the single gas challenge or linearity test. A general outline of items to cover is provided in Table 8-2. A sample procedure for linearity testing is provided in Appendix A of this manual.

Table 8-2:
Elements of a Standard Operating Procedure for Performance Testing

Procedure Element	Description/Purpose
Pre-Test Survey	Contact the source to schedule the test, verify CEMS calibration information, and review test logistics.
Pre-Test Equipment Preparations	Select and prepare test equipment.
Pre-Test Meeting	Plant meeting the day of the test. Review of test procedures and any special circumstances.
Equipment Set-up	Outline of steps to set up the test equipment.
Test Procedure	Step by step procedures for the test itself, including calculations.
Pack-up Procedure	Description of equipment breakdown after the test is completed.
Post-Test Meeting	Provide source with the test results.

8.5 Single Gas Challenge

The single gas challenge uses one protocol gas to challenge the CEMS at one point in the measurement range. It has a logistical advantage over performing a linearity test. One tri-blend gas cylinder can cover CO_2, SO_2, and NO_x, and there is no need for a manifold or trailer. The disadvantage is that only one point in the measurement range is tested. EPA recommends that if a single gas challenge is performed, a mid level gas be selected (~ 40 - 60 percent of span). Have the source perform a daily calibration error test so that the full scale can be evaluated. This approach minimizes the resources required, but most closely approximates a full linearity test.

When you perform the single gas challenge, connect your calibration gas cylinder to the source's calibration gas manifold. Keep in mind the "hands off" policy. You should perform three runs. For each run:

- Inject gas, wait for the response to fully stabilize, and record value from the DAHS; and
- Allow system to sample stack gas and equilibrate before the next run.

Based on this test, the percent error is calculated in the same manner as the linearity error:

$$LE = \frac{|R - A|}{R} \times 100$$

where:

LE	=	Percent linearity error
R	=	Reference value of calibration gas
A	=	Average of monitoring system responses

8.6 Linearity Test

Linearity test procedures and requirements are outlined in Part 75, Appendix A, § 6.2. There are two approaches your agency might take with regards to the logistics of on-site linearity testing. The first approach is similar to the single gas challenge in that you bring your own calibration gases to the site and have the source connect each of your three cylinder gases (low, mid, and high) to the plant calibration gas manifold. The other approach is to provide your own gas delivery manifold set-up with your cylinders in a truck or trailer and have the source attach your gas delivery line to the CEMS injection point.

You will challenge the CEMS three times with each audit gas. The audit gas is injected at the gas injection port required in Part 75, Appendix A, § 2.2.1. The same gas concentration or level is not used twice in succession. Sufficient time should be allowed for the concentration reading to stabilize for each gas injection. The average CEMS response will be taken from the DAHS as the official component for recording the CEMS data. You then calculate the percent error using the same equation identified in Section 8.5, above.

8.7 Calibration Gases

As noted earlier, a tri-blend gas containing SO_2, NO_x, and 11 percent CO_2 is recommended for agency audits of SO_2 and NO_x monitors. The number of different calibration gases that your agency will need is dependent on the spans of the CEMS installed on units in your area. At least three audit gases will be needed to conduct the linearity test at a unit: one having a value 20 to 30 percent of span, the second with a value of 50 to 60 percent of span and the third with a value of 80 to 100 percent of span. Review the monitoring plans for the units in your area to identify which gases you will need. Your agency should develop a standard operating procedure for maintaining the calibration gas inventory.

8.8 Training

Table 8-3 lists available EPA training courses pertaining to gas CEMS and analyzer calibration. Two of the courses, APTI 435 and APTI 464, are geared to operating an ambient monitoring system, but include instructions on how to calibrate gas analyzers that are directly applicable to performing a single gas challenge or linearity test on a Part 75 gas CEMS.

Table 8-3:
Available EPA Training Courses

EPA Course Number	Course Title
APTI 435	Atmospheric Sampling
APTI 464	Analytical Methods for Air Quality Standards
APTI 450	Source Sampling for Pollutants
APTI 474	Continuous Emission Monitoring
SI 476B	Continuous Emission Monitoring Systems Operation and Maintenance of Gas Monitors