

Continuous Monitoring Manual

January, 1992

Revisions:
April, 2015

Operations Division

811 SW 6th Avenue
Portland, OR 97204
Phone: 503-229-5696
800-452-4011
Fax: 503-229-5850
Contact: Jill Inahara
www.oregon.gov/DEQ

DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.



State of Oregon
Department of
Environmental
Quality

This report prepared by:

Oregon Department of Environmental Quality
811 SW 6th Avenue
Portland, OR 97204
1-800-452-4011
www.oregon.gov/deq

Contact:

Mark Bailey, 541-633-2006
Jill Inahara, 503-229-5001

Alternative formats (Braille, large type) of this document can be made available.
Contact DEQ's Office of Communications & Outreach, Portland, at
503-229-5696, or toll-free in Oregon at 1-800-452-4011, ext. 5696.

Table of Contents

Executive Summary iv

1.0 Introduction..... 1

2.0 Monitoring Objectives 1

 2.1 Program Objectives 1

 2.2 Data Quality Objectives 1

3.0 Continuous Monitoring Plans 2

 3.1 Standard operating procedures 2

 3.2 Quality Control/Quality Assurance Plan 3

4.0 Continuous Emission Monitoring Systems 4

 4.1 CEMS Equipment and Installation Specifications 4

 4.2 Performance Assessments for CEMS 4

5.0 Continuous Parameter Monitoring Systems..... 5

6.0 Continuous Opacity Monitoring Systems (COMS) 6

7.0 Recordkeeping and Reporting..... 6

Appendix A – DEQ Continuous Emission Monitoring Requirements A

Appendix B – DEQ Continuous Parameter Monitoring Requirements B

Appendix C – DEQ Recordkeeping and Reporting Requirements C

Executive Summary

DEQ's Continuous Monitoring Manual provides specifications and procedures for conducting continuous monitoring at facilities regulated by DEQ's stationary source air quality permit program. The manual includes requirements for preparing monitoring plans that include standard operating and quality assurance procedures to ensure that continuous monitor systems will provide accurate and reliable data. The manual is applicable to continuous emission monitoring systems (CEMS), continuous parameter monitoring systems (CPMS), and continuous opacity monitoring systems (COMS). In addition to DEQ specific requirements, the manual incorporates by reference federal monitoring requirements contained in 40 CFR Parts 60, 63, and 75. The Continuous Monitoring Manual was first written in 1992 and revised in 2015. The Continuous Monitoring Manual is included in Oregon's State Implementation Plan.

1.0 Introduction

This manual provides guidance and direction to owners and operators that are responsible for continuously monitoring air emissions, operating parameters, or opacity from their facilities. For purposes of this manual, continuous monitoring systems (CMS) are divided into three (3) main subgroups:

- Continuous Emission Monitoring Systems (CEMS),
- Continuous Parameter Monitoring Systems (CPMS), and
- Continuous Opacity Monitoring Systems (COMS).

CMS that are required by permit condition, but not subject to federal regulations are subject to the requirements of this manual. This manual also applies to CMS that are required by the following federal standards. The monitoring requirements specified in the federal standards are incorporated by reference as published in the July 2012 Code of Federal Regulations (CFR). If there is an inconsistency between the requirements of this manual and the federal requirements, the federal requirement will take precedence:

- New Source Performance Standards (NSPS), 40 CFR Part 60;
- National Emissions Standards for Hazardous Air Pollutants (NESHAP), 40 CFR Part 63; and
- Acid Rain Program, 40 CFR Part 75.

When required to perform continuous monitoring by DEQ, CMS operators are required to perform the monitoring in accordance with this manual, at a minimum, to ensure reported data are complete and of high quality. Operators may choose more rigorous specifications or more sophisticated procedures appropriate for their purposes.

2.0 Monitoring Objectives

2.1 Program Objectives

The objectives of a monitoring program will vary depending on the regulation or permit, but may include one or more of the following. The CMS must be designed to meet the appropriate objectives.

- Measure air contaminant concentrations and operating parameters as required by permit or regulation;
- Ensure high quality data is collected to determine continuous compliance with permit or regulation;
- Prevent possible adverse environmental effects;
- Determine emissions improvements and trends in conjunction with process changes; or
- Provide accurate and reliable data as part of an integrated emissions inventory program.

2.2 Data Quality Objectives

Each monitoring program must meet specific data quality objectives. These are data completeness, representativeness, accuracy, precision, and comparability. A brief description of each objective is provided below.

- Completeness is the measure of the number of valid data points collected over the possible number of data points in a period of time.
- Representativeness refers to measurements which accurately depict the condition of interest. One aspect of representativeness involves the method chosen to perform the monitoring; it must be accurate in both a qualitative and quantitative sense.
- Accuracy describes how close the measurement is to the "true value" of the quantity being measured.
- Precision is a measure of variability, or scatter, of the system's response to repeated challenges by the same standard. Precision is a measure of repeatability, how closely multiple measurements agree.
- Comparability is a measure of how data sets are similar or different. It determines how data sets can be used collectively.

3.0 Continuous Monitoring Plans

The source operator must prepare and maintain written standard operating procedures (SOP) and a quality assurance plan (QAP) for each continuous monitoring system used at a source. The SOP and QAP must be submitted to DEQ prior to operation of a CMS. These documents must be reviewed periodically by the CMS operator and revised as necessary based on experience with the CMS. The SOP and QAP must contain detailed, complete, step-by-step written procedures. Both documents must be made available to DEQ personnel for inspection upon request.

3.1 Standard operating procedures

Standard operating procedures (SOP) must be written for each CMS. The contents of the SOP must include, as a minimum, the following information:

- a. Source owner or operator name and address.
- b. Identification, description, and location of monitors in the CMS.
- c. Description and location of the sample interface (i.e. sample probe).
- d. Manufacturer and model number of each monitor in the CMS.
- e. Equipment involved in sample transport, sample conditioning, analysis, and data recording.
- f. Procedures for routine operation checks, including daily zero and span calibration drift (CD) check.
- g. Procedures for routine preventive maintenance. Initially, these procedures can be taken from the manufacturer's installation and operation manuals. However, as the CMS operators gain more experience with the CMS, it may

- be necessary or desirable to modify these procedures to increase or decrease frequency of maintenance and add or delete some procedures.
- h. Routine maintenance spare parts inventory.
 - i. Procedures for calculating and converting CMS data into the reporting units of the standard.
 - j. Documentation of the activities described in 3.1 a – i.

3.2 Quality Assurance Plan

Prior to initiating a continuous monitoring program, a written quality assurance plan (QAP) must be prepared. The QAP must include quality control and quality assurance procedures for ensuring that the CMS will provide accurate and reliable data. For these purposes, the terms "Quality Control" (QC) and "Quality Assurance" (QA) are defined as follows:

- "Quality Control" refers to an activity carried out during routine internal operations to ensure that the data produced are within known limits of accuracy and precision. Examples of QC activities include periodic calibrations, routine zero and span checks, routine leak checks, routine check of optical alignment, etc. QC represents the core activity in a Quality Assurance program.
- "Quality Assurance" refers to all of the planned and systematic activities carried out externally and independent of routine operation to document data quality. QA activities include written documentation of operation, calibration, and QC procedures; independent system and performance audits; data validation; evaluation of QC data; etc. QA requires documentation of all aspects of the CMS effort, from the responsibilities of each person involved to how the data are reported.

The contents of the QAP are dependent on the applicable regulation or permit condition. Some systems may be subject to multiple regulations, and therefore multiple plan requirements. The plan should be reviewed annually and updated when there are changes to equipment and procedures. Plan updates should be submitted to DEQ for review. In general, a satisfactory QAP plan includes the following:

- a. Data quality objectives.
- b. Chain of responsibility for CMS operation, corrective action, and training program.
- c. Procedure for measuring the CMS accuracy and precision including the following:
 - CMS calibrations
 - Zero and span drift checks
 - Performance audits
 - System audits
- d. Quality control activities
- e. Quality control documentation
- f. Procedures for data recording, calculations, and reporting
- g. Criteria for taking corrective actions

h. Procedures for corrective action

Monitoring plan requirements for various regulations are summarized in the following table.

REGULATIONS	AQ/QC PROGRAM PLAN REQUIREMENTS
NSPS	40 CFR Part 60, section 60.13 and appendix F, section 3
NESHAP	40 CFR Part 63, Subpart A, Section 63.8
Acid Rain Program	40 CFR Part 75, Appendix B, Section 1.

* This table may not include all references to applicable monitoring plan requirements.

4.0 Continuous Emission Monitoring Systems

4.1 CEMS Equipment and Installation Specifications

Equipment specifications, installation, and measurement location are defined according to the applicable performance specification. Refer to the following reference table for equipment specifications, installation, and measurement location requirements.

REGULATIONS	EQUIPMENT SPECIFICATIONS, INSTALLATION & MEASUREMENT LOCATION REQUIREMENTS
NSPS	40 CFR Part 60, section 60.13 and appendix B
NESHAP	40 CFR Part 63, section 63.8
Acid Rain Program	40 CFR Part 75, Subpart A – H and appendices A-J
Oregon DEQ Requirements	Appendix A of this manual

*This table may not include all references to applicable equipment and installation requirements.

4.2 Performance Assessments for CEMS

Performance assessments are utilized to determine quality of monitored data. In general, most regulations divide the assessments into four (4) separate activities:

- Initial performance specifications
- Daily performance assessments
- Quarterly performance assessments, and
- Annual performance assessments.

The requirement of each assessment depends on the applicable performance specifications and the QA/QC requirements. Performance assessments requirements are detailed below.

REGULATIONS	PERFORMANCE ASSESSMENTS
NSPS	40 CFR Part 60, Appendices B & F
NESHAP	40 CFR Part 63, section 63.8
Acid Rain Program	40 CFR Part 75, Subparts A – H and appendices A and B
Oregon DEQ Requirements	Appendix A of this manual

*This table may not include all references to applicable performance assessment requirements.

5.0 Continuous Parameter Monitoring Systems

A continuous parameter monitoring system (CPMS) continuously monitors source or pollution control device operating parameters. These may include, but are not limited to:

- Fuel consumption rates;
- Production rates;
- Oxygen concentration;
- Moisture content;
- Process temperatures;
- Pollution control device parameters (e.g., pressure drop, voltages, water flow and pressure, etc.)

There are three basic types of CPMS:

- CPMS used for the purpose of determining pollutant emissions rates (PEMS);
- CPMS used for the purpose of monitoring pollution control device operations; and,
- CPMS used for the purpose of monitoring source operations.

It is not the intention of this manual to cover each and every possible CPMS. Requirements for CPMS that are used for determining pollutant emissions rates are generally found within applicable federal regulation. CPMS requirements are detailed below.

REGULATIONS	CPMS REQUIREMENTS
NSPS	40 CFR Part 60, applicable subparts and appendices B and F
NESHAP	40 CFR Part 63, Applicable subparts
Acid Rain Program	40 CFR Part 75, Subpart E and appendices D and E
Oregon DEQ Requirements	Appendix B of this manual

*This table may not include all references to applicable CPMS performance requirements.

6.0 Continuous Opacity Monitoring Systems (COMS)

This section addresses specific requirements for the operation of continuous opacity monitoring systems (COMS). These requirements do *not* supersede any requirements specified by rule, regulation, or by permit condition.

Existing COMS installed prior to 6/1/91 must be maintained and operated in accordance with permit requirements; and, unless otherwise specified, are not subject to the requirements of this manual. If the COMS system is not subject to federal regulation and is installed, replaced, relocated or substantially refurbished after 6/1/91, then the COMS must satisfy 40 CFR Part 60, Spec. 1 requirements in effect at the time of the change.

All continuous opacity monitoring systems (COMS) must complete a minimum of one cycle of sampling and analyzing for each successive 10-second period (15 seconds for non-NSPS sources if approved by the DEQ).

Federal requirements for COMS can be found within the applicable federal regulations cited below.

REGULATIONS	COMS REQUIREMENTS
NSPS	40 CFR Part 60, section 60.13 and appendix B, specification 1
NESHAP	40 CFR Part 63, section 63.8
Acid Rain Program -Optional Emissions Protocols	40 CFR Part 75, Subpart B

*This table may not include all references to applicable COMS performance requirements.

7.0 Recordkeeping and Reporting

This section addresses specific requirements for recordkeeping and reporting requirements for CMS. If inconsistencies exist, these requirements do not supersede any requirements specified by regulation or permit condition.

The source owner or operator must maintain records of all CMS activities in a file and/or log book. This record must be used by the CMS operator to ensure that the CMS is operating correctly. The record must also be made available to DEQ personnel upon request.

Continuous Monitoring Manual

Recordkeeping and reporting requirements for various regulations are cited below.

REGULATIONS	RECORDKEEPING & REPORTING REQUIREMENTS
NSPS	40 CFR Part 60, applicable subparts and appendix F
NESHAP	40 CFR Part 63, applicable subparts
Acid Rain Program	40 CFR Part 75, subparts E, F and G and appendices B, D, and E
Oregon DEQ Requirements	Appendix C of this manual

*This table may not include all references to applicable recordkeeping and reporting requirements.

Appendix A

DEQ Continuous Emission Monitoring Requirements

General continuous emissions monitoring requirements are outlined below. These requirements do not supersede any requirements specified by regulation or permit condition. Refer to Section 4.0 of this monitoring manual.

A.1 CEMS Not Required by Federal Program and Installed after 6/1/91

1. The CEMS must continuously monitor and record the concentration of gaseous pollutant emissions on a wet or dry basis discharged into the atmosphere. The CEMS must consist of subsystems for sample extraction, conditioning, detection, analysis, and data recording/processing.
2. All CEMS must meet the requirements of 40 CFR 60 Appendix B (performance specifications) and Appendix F (QA/QC procedures).
3. All continuous emissions monitoring systems (CEMS) must complete a minimum of one cycle of sampling and analyzing for each successive 15-minute period unless the DEQ has specified a different frequency (i.e. Medford AQMA requires one minute cycle).

A.2 CEMS Not Required by Federal Program and Installed Prior to 6/1/91:

1. The CEMS must continuously monitor and record the concentration of gaseous pollutant emissions discharged to the atmosphere from any stationary source using CEMS approved by DEQ.
2. The span of the CEMS must be set:
 - a. At 200% of the permit requirement concentration or the emission standard, whichever is lower. The span may be set at alternative values with DEQ approval.
 - b. The CEMS must be capable of recording down-scale drift below zero.
3. The CEMS must be pollutant specific and free from interferences. (e.g.: For TRS CEMS, the measured TRS must exclude SO₂)
4. The CEMS analyzer must be maintained in an environment conducive to analyzer stability.
5. Extractive CEMS operating procedures must include automatic back-flushing of sample line and probe to purge condensed moisture and particulate material.
6. If the emissions must be corrected for diluent oxygen, periodically test and record the concentration of oxygen in the exhaust gases using an oxygen CEMS, Orsat Analyzer, or equivalent.
 - a. An Oxygen CEMS, if used, must be calibrated according to written procedures, approved by the Department, at least twice each year using two calibration gases having oxygen concentrations of approximately 5 and 15 percent by volume, accurate to within 0.5% oxygen.

- b. Oxygen must be measured at least semi-annually, after any major maintenance/-repair on duct work, and frequently enough to be representative of average oxygen concentration.
7. The zero and span drift of CEMS must be measured and recorded daily when the CEMS is in operation. Span gases used for this procedure need not be NIST traceable. However, the concentration of the gases should be verified by an analyzer calibrated with certifiable calibration gases. It may be necessary to periodically certify the concentration of the zero and span drift check gases.
8. A cylinder gas audit (CGA) of the CEMS must be performed weekly with successive CGAs performed no closer than six days apart. The CGA must include a "zero" gas and a minimum of one upscale gas concentration at approximately 60 percent of analyzer full-scale. The CGA results must satisfy the audit specifications outlined within 40 CFR 60, Appendix F.
 - a. If 4 consecutive weekly CGAs result in the CEMS being within the allowable specifications, the frequency of the CGAs may be reduced to once each month with successive CGAs performed no closer than 21 days apart.
 - b. If three consecutive monthly CGAs result in the CEMS being within specifications, the frequency of the CGAs may be reduced to once each quarter with successive CGAs performed no closer than two months apart.
 - c. If two consecutive quarterly CGAs result in the CEMS being within specifications, the CGA frequency may be reduced to once every six months with successive CGAs no closer than five months apart.
 - d. The minimum CGA frequency must be once every six months with successive CGAs no closer than five months apart.
 - e. The CGA frequency must revert back to a weekly frequency if a CGA results in the CEMS failing to meet the performance specifications of 40 CFR Part 60, Appendix F.
 - i. The concentration of the cylinder audit gases must be traceable to National Institute of Standards and Technology (NIST) standard reference materials (SRM) or EPA certified reference materials (CRM) and reanalyzed every 6-months using EPA Reference Methods (40 CFR 60, Appendix A). Gases may be analyzed at less frequent intervals if the manufacturer guarantees their certified concentration for longer time periods.
 - ii. Cylinder gases must be introduced to include as much of the monitoring system as feasible, in no case may gas conditioning subsystems (i.e. SO₂ scrubbers for TRS CEMS) be excluded or by-passed.
9. A Relative Accuracy Audit (RAA) must be performed at least once each year. The RAA may satisfy one of the CGA requirements. RAA must satisfy the audit specifications outlined within 40 CFR 60, Appendix F.
10. If the CEMS system is not subject to federal regulation and is installed, replaced, relocated or substantially refurbished after 6/1/91, then the CEMS is not applicable to the requirements of this section and must comply with section A.1 of this appendix.
11. As an alternative to complying with conditions 1 through 9 of this section, the owner/operator may choose to comply with the requirements of section A.1 of this appendix.
12. Data must be recorded in units of the standard.

APPENDIX B

DEQ CONTINUOUS PARAMETER MONITORING REQUIREMENTS

General continuous parameter monitoring requirements are outlined below. These requirements do not supersede any requirements specified by rule, regulation, or by permit condition. Refer to Section 5.0 of this manual.

B.1 CPMS General Requirements:

1. CPMS must be installed in a location that is representative of the monitored process and free from interferences.
2. CPMS must be installed and maintained in an environment conducive to CPMS stability and data reliability.
3. CPMS must be calibrated and certified by the manufacturer prior to installation. (Applies to CPMS installed after 6/1/91).
4. All CPMS must complete a minimum of one cycle of sampling and analyzing for each successive 15-minute period unless the DEQ has specified a different frequency (i.e. Medford AQMA requires one minute cycle).

B.2 Pollutant Emissions Related CPMS

1. CPMS for the purpose of determining emission rates (i.e. stack gas flow monitoring devices) require the highest level of QA/QC. If CPMS system is installed to satisfy 40CFR Parts 60 and 75, then requirements specified by those regulations must be followed.
 - a. CPMS installed after 6/1/91 must meet 40 CFR Part 60 Appendix B performance specification 6. The reference methods for determining relative accuracy (RA) are EPA or DEQ methods 1 through 4.
 - b. Performance audits must be conducted quarterly in conjunction with the CEMS audits. It may not be possible to conduct audits on some CPMS. Exemption from this requirement must be approved by DEQ.
2. Stack Gas Flow Monitoring

CPMS data are necessary for converting emission concentrations to units of the standard. This is accomplished by continuously monitoring stack gas flow rates to calculate the emissions as a rate (pounds per hour) in addition to the CEMS output (percent or parts per million).

There are several acceptable alternatives for measuring flow rates (ultrasonic sensors, pitot tubes, process rates - steam, air flows, etc.). The CPMS must include the capability to measure and/or assume the following variables for determining the stack gas flow rate.

- Stack gas temperature,
- Stack gas pressure (absolute),
- Stack gas moisture content,
- Stack gas molecular weight,
- Stack gas velocity, and
- Cross-sectional area of the stack at the point of velocity measurements.

Flow rate metering systems generally measure and record the velocity, or velocity pressure (fifth bullet item 5 above). Other parameters are either directly or indirectly measured. In some circumstances parameters can be accurately assumed based on historical data collected from the source.

B.3 Pollution Control Device Related CPMS

1. Pollution control device related CPMS include but are not limited to:
 - Operating pressure and/or temperature,
 - Water flow rate, temperature, and/or pressure
 - Electrical current and voltage, and
 - Cycle time.
2. Calibration checks must be performed in accordance with the manufacturer's procedures at least once per month. Depending on the CPMS, an exemption from this requirement may be obtained from the DEQ upon written request. For example, water flow devices are typically calibrated only once, prior to installation.

B.4 Source Operation Related CPMS

Source related CPMS include but are not limited to:

- Steam flow & pressure meters,
- Fuel flow meters,
- Operating temperatures & pressures,
- Excess air levels,
- Hour meters and cycle time.

At a minimum, source related CPMS must meet the general CPMS requirements listed above. Depending on the CPMS, an exemption from this requirement may be obtained from the DEQ upon written request. Temperature CPMS must be calibrated during each planned maintenance outage or annually, whichever is more frequent.

APPENDIX C

DEQ RECORDKEEPING AND REPORTING REQUIREMENTS

General DEQ CMS recordkeeping and reporting requirements are outlined below. These requirements do not supersede any requirements specified by regulation or permit condition. Refer to Section 7.0 of this monitoring manual.

C.1 Recordkeeping

The source owner or operator must maintain records of all CMS activities in a file and/or log book. This record must be used by the CMS operator to ensure that the CMS is operating correctly. The record must also be made available to DEQ personnel upon request. The record must include as a minimum the following information:

1. Records of routine observation checks.
2. Records of routine maintenance and adjustments.
3. Records of parts that are replaced.
4. Spare parts inventory for the CMS.
5. Records of CMS calibrations.
6. Records of CMS daily calibration drift.
7. Records of CMS audits.
8. Records of corrective action taken to bring an “out-of- control” (40CFR60 App F) CMS into control.
9. Records of date and time when CMS is inoperative or “out-of-control” (40CFR60 App F).

C.2 Reporting Requirements

The source owner or operator may be required, by permit condition, to submit monitoring reports to the DEQ. These reports must include as a minimum the following information:

1. Reporting period (determined by permit condition).
2. CMS type, manufacturer, serial number, and location.
3. Monitoring data must be reduced and reported as follows (unless otherwise specified by permit or rule):
 - a. For opacity monitoring systems (COMS):
 - i. 6-minute (clock) averages
 - ii. Hourly (clock) averages
 - iii. Monthly average of the hourly averages.
 - b. For emissions monitoring systems (CEMS):
 - i. Hourly (clock) averages.
 - ii. Monthly average of the hourly averages.
4. Data completeness information. The following completeness requirements are essential for a CMS data average to be accepted (unless otherwise specified by permit or rule):
 - For a 6-minute or 1-hour reporting period, a minimum of 75% of the data must be included in the average.
 - For a 24-hour or monthly reporting period, a minimum of 90% of the data must be included in the average.

Insufficient data completeness, excluding CMS downtime due to daily zero and span checks and performance audits, will void that data period. All data collected must be reported. Non-valid data must be highlighted. Data recorded during periods of CMS breakdowns, repairs, audits, calibration checks, and zero and span adjustments must not be included in the data averages.

5. Specific identification and supporting documentation, as required by rule or by permit condition, for each period of excess emissions that occurs.
6. The date and time identifying each period during which the CMS was inoperative (out-of-control as per 40CFR60 App F) except for zero and span checks and the nature of the CMS repairs or adjustments.
7. Reporting requirements for CMS performance assessments conducted during the reporting period are outlined below. Assessment requirements are dependent on applicable performance specifications and QA/QC requirements. Additional reporting requirements may be stipulated by permit or DEQ communication.
 - Results of initial performance assessment, submit to DEQ.
 - Results of daily performance assessments, submit to DEQ upon request.
 - Quarterly performance assessments, submit to DEQ upon request.
 - Semiannual performance assessments, submit to DEQ upon request.
 - Annual performance assessments, submit to DEQ.
 - Performance assessments not specifically listed above, submit to DEQ upon request.