مجلس أبوظبي للجودة والمطابقة
ABU DHABI QUALITY & CONFORMITY COUNCIL

Abu Dhabi Guideline

دليل أبوظبي الإرشادي

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الاصدار الأول

Abu Dhabi Guideline for Continuous Emission Monitoring System CEMS

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About the Abu Dhabi Quality and Conformity Council

The Abu Dhabi Quality and Conformity Council (QCC) was established by law No. 3 of 2009, issued by His Highness Sheikh Khalifa Bin Zayed Al Nahyan, President of the UAE.

QCC is responsible for the development of Abu Dhabi Emirate's Quality Infrastructure, which enables industry and regulators to ensure that products, systems and personnel can be tested and certified to UAE and International Standards.

Products certified by QCC receive the Abu Dhabi Trustmark. The Trustmark is designed to communicate that a product or system conforms to various safety and performance standards that are set by Abu Dhabi regulators.

Amendment Page

To ensure that each copy of this ADG contains a complete record of amendments, the Amendment Page is updated and issued with each set of revised/new pages of the document. This Guideline is a live document which can be amended when necessary. QCC operates the Group which prepared this document and can review stakeholder comments in order to review and amend this document, issuing an updated version when necessary.

Edition	Date	Description/Notes
1.0	2019	The first edition issued by QCC.

Acknowledgements

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No.	Name	Entity
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Executive Summary

The purpose of this Guideline is to advise facilities within Abu Dhabi Emirate subject to the regulations of Environment Agency – Abu Dhabi (EAD) of the requirements to be met by a continuous emission monitoring system. It is an elaboration of the requirements in the regulations and has been adopted by the Abu Dhabi government. Abu Dhabi Emirate CEMS Guideline establishes requirements for the installation, operation, maintenance, and performance assessment of continuous emission monitoring systems. These requirements will ensure effective measurement, recording, and reporting of specified emissions and other parameters.

In addition, the Guideline establishes requirements for alternative monitoring systems and for the performance assessment of continuous emission monitoring data. The CEMS Guideline contains performance specifications for common CEMS systems, namely for those monitoring, as applicable:

- Sulphur dioxide (SO_2);
- Oxides of nitrogen (NO_x);
- Carbon monoxide (CO);
- Total reduced sulphur (TRS);
- Hydrogen sulfide (H_2S);
- Oxygen (O_2);
- Carbon dioxide (CO_2);
- In-stack opacity;
- Volumetric flow/velocity; and
- Temperature.

Abbreviations and Units

AS = Australian Standard

°C = degrees Celsius

CGA = Cylinder Gas Audit

CEMS = continuous emission monitoring system

CFR = Code of Federal Regulations (United States of America)

CO = carbon monoxide

CO_2 = carbon dioxide

DCS = data control system

EAD = Environment Agency-Abu Dhabi

ENAS = Emirates National Accreditation System

°F = degrees Fahrenheit

H_2S = hydrogen sulfide

K = kelvin

kPa = kilopascals

mm Hg = millimetres mercury

m/sec = metres per second

NATA = National Association of Testing Authorities (accreditation body)

NIST = National Institute of Standards and Technology (USA)

nm = nanometre

NO_x = oxides of nitrogen

O_2 = oxygen

PLC = programmable logic controller

ppmv = parts per million volume

QA = quality assurance

QAP = quality assurance plan

QC = quality control

QCC = Abu Dhabi Quality and Conformity Council

sec = second

°R = degrees Rankine

RATA = relative accuracy test audit

RM = reference method

SCADA = supervisory control and data acquisition

SO_2 = sulphur dioxide

TRS = total reduced sulphur

USEPA = United States Environmental Protection Agency

General

Abu Dhabi CEMS Guideline establishes requirements for the installation, operation, maintenance, and performance assessment of continuous emission monitoring systems. These requirements will ensure effective measurement, recording, and reporting of specified emissions and other parameters. In addition, the Guideline establishes requirements for alternative monitoring systems and for the performance assessment of continuous emission monitoring data.

Purpose and Intent

Environmental compliance air monitoring may be required in a project's or facility's Construction Environmental Management Plan, Operation Environmental Management Plan, Decommissioning Environmental Management Plan, or operating permit. Environment Agency – Abu Dhabi (EAD) has the legal mandate to request that facilities install CEMS or any other air monitoring systems during any phases of a project. EAD uses the permit conditions or environmental studies outcomes to communicate the monitored pollutants and reporting frequency to the facility proponent. The Abu Dhabi Continuous Emission Monitoring System (CEMS) Guideline, is hereafter referred to as the "CEMS Guideline"

The CEMS Guideline contains performance specifications for the majority of CEM system requirements that are referenced in facility approvals. For those CEM systems for which specifications are not included in this Guideline, new methods will be incorporated into the CEMS Guideline as they are developed.

CEMS Linking with EAD

EAD launched a CEMS linking program to link all CEMS readings instantly to the EAD system. All facilities that have installed CEMS in Abu Dhabi should electronically link their systems to the EAD system whenever they are requested to do so. This linkage will allow EAD to access to the emission readings. The data acquisition and handling system used for the CEMS should be compatible with the Webservice data link documentation prepared by EAD to allow the data transfer between the facility CEMS and the EAD system.

Facilities that have their data acquisition and handling system linked with the EAD system will be exempt from some of periodic reporting. According to this Guideline, the data generated should be kept, archived, and submitted to EAD upon request.

CEMS Data Use

In Abu Dhabi Law No. (16) of 2005 pertaining to the reorganization of the Abu Dhabi Environment Agency, the Cabinet Order No. (12) of 2006 regarding Regulation Concerning Protection of Air from Pollution and UAE federal law No.(24) of 1999 for the Protection and Development of the Environment , EAD is the responsible entity for issuing the appropriate measures to monitor the compliance of all sources of emission to air with the applicable limits and standards. The measures include the conditions for CEMS installation for any facility permitted by EAD when such a system is required. All data generated by a CEMS (where the use of that CEMS is linked to the EAD approval for its associated facility) can be used as a basis for enforcement, other CEMS data would be used only to fulfil performance assessment requirements.

Existing CEMS Installations

A number of existing facilities, approved prior to the issuance of this CEMS Guideline, may have CEMS that do not fully comply with the CEMS Guideline with respect to either of the following, namely:

(a) Installation requirements; or

(b) Equipment required to conduct various quality control procedures (for example, calibration gas may not be introducible at the proper location in some of the older designs, etc.).

Each facility, as applicable, recommended to assess (according to a schedule agreed by EAD), on the basis of technical merit, whether CEMS installation, operational and performance specification requirements can be achieved with the existing configuration. This assessment is to ensure that the facility's CEMS can meet CEMS Guideline specification requirements. If the CEMS can meet these requirements, then no further action would be required; if not, then the facility recommended to establish a reasonable program, acceptable to EAD, to upgrade the CEMS installation so it meets all of the Guideline requirements.

1. PHASE I – DESIGN REQUIREMENTS

For new installations, the following information regarding the CEM system must be submitted to EAD at least sixty (60) working days prior to system installation:

A. Describe in general terms the process(es) and pollution control equipment, along with all factors that may affect the operation of the monitoring system.

B. Describe the location of the monitoring system/sample acquisition point(s) or path(s) in relation to flow disturbances (fans, elbows, inlets, outlets), pollution control equipment, flue walls, and emission point of the monitored effluent streams to the atmosphere.

C. List the following system information:

- pollutant(s) or parameters to be monitored;
- the operating principles of the analyzer(s);
- the number of analyzers, and the number of acquisition point(s) or path(s) for an analyzer, or bank of analysers sharing multiple ducts (time sharing systems);
- the equipment manufacturer and model number(s), a copy of the checklist to be used by the instrument technician for periodic checking of the analyzer(s); and
- the expected normal and maximum analyzer or flow rate readings.

D. Describe the process and pollution control equipment operating parameters that affect the emission levels of the pollutants being monitored or the parameters being monitored, and also explain the method to be used to record these parameters.

E. Describe calibration, operational and maintenance procedures, along with recommended schedules.

F. Explain procedures to be used to satisfy the requirements for record keeping as defined by EAD.

1.1 Design Specifications for Monitors and Analyzers

1.1.1 Design specifications for sulphur dioxide, oxides of nitrogen and carbon monoxide analyzers

Continuous Emission Monitoring Systems for monitoring gases consists of the following four subsystems:

- Sample Interface/Conditioning;
- Gas Analyzers;
- Data Acquisition;
- Flow monitor (where applicable).

The acceptability of emission monitoring systems is in general, performance based; however minimal design specifications are specified for gas analyzers, in-stack opacity monitors, and flow monitoring systems. These specifications have been established either to ensure the overall stability of the CEMS once the analyzers are incorporated into the system, or to ensure that accurate readings will be obtained for the parameter being measured. The verification of design specifications are given in this Guideline, and unless otherwise authorized by EAD, the chosen range of each monitor is specified in Tables 1 to 6. If the average monthly parameter of any analyzer should fall outside these limits, the analyzer span should be adjusted so that the average is brought back within these limits. If emission values vary widely, the use of multi-range analyzers is encouraged. Data that fall outside the range of an analyzer are considered to be missing.

Table 1: Design specifications for sulphur dioxide, oxides of nitrogen and carbon monoxide analyzers

Design Specification	Sulphur Dioxide Analysers	Oxides of Nitrogen Analysers	Carbon Monoxide Analysers
Lower detection limit	≤ 2% of span	≤ 2% of span	≤ 2% of span
Interference rejection (sum total)	≤ ± 2% of span	≤ ± 4% of span	≤ ± 4% of span
Analyser span[a]	≥ 1.5 times licence limit	≥ 1.5 times licence limit	≥ 1.5 times licence limit
Temperature-responsive zero drift[b]	≤ ± 4% of span	≤ ± 4% of span	≤ ± 4% of span
Temperature-responsive span drift[b]	≤ ± 3% of span	≤ ± 4% of span	≤ ± 4% of span
Response time (95%)	≤ 200 seconds	≤ 200 seconds	≤ 200 seconds
Cycle time	≤ 15 minutes	≤15 minutes	≤ 15 minutes

[a] The minimum requirement for Analyser Span is intended to provide some flexibility in selecting a manageable span. It is expected that the chosen span will not be so large that unreasonable uncertainty is created in the measured value. If large variance is expected in the measured values (i.e. spikes), then dual-span analysers should be used to capture the full range of occurrences.

[b] For every 10°C change in analyser operating temperature within the ambient range of 5°C to 35°C.

1.1.2 Design Specifications for Total Reduced Sulphur (TRS) and Hydrogen Sulfide Analysers

Total reduced sulphur (TRS) and hydrogen sulfide (H2S) analysers (and the affiliated system, as applicable) must satisfy the design specifications in Table 2.

Table 2: Design specifications for total reduced sulphur (TRS) and hydrogen sulfide analysers

Design Specification	TRS Analyser	Hydrogen Sulfide Analyser
Lower detection limit	≤ 2% of span	≤ 2% of span
Interference rejection (sum total)	≤ + 4% of span	≤ + 4% of span
Analyser span	1.5 times licence limit or 30 ppmv, whichever is the greater	1.5 times licence limit or 30 ppmv, whichever is the greater
Response time (95%)	≤ 200 seconds	≤ 200 seconds
Cycle time	≤ 15 minutes	≤ 15 minutes
Design Specification	TRS Analyser	Hydrogen Sulfide Analyser

1.1.3 Design Specifications for Oxygen and Carbon Dioxide Dilution Analysers

Oxygen (O_2) and carbon dioxide (CO_2) dilution analysers (and the affiliated system, as applicable) must satisfy the design specifications in Table 3.

Table 3: Design specifications for oxygen and carbon dioxide dilution analysers

Design Specification	Oxygen Analysers[a]	Carbon Dioxide Analysers[a]
Lower detection limit	≤ 0.5% O_2	≤ 0.5% CO_2
Interference rejection (sum total)	≤ + 1.0% O_2	≤ ± 1.0% CO_2
Analyser span	0 – 21% O_2	0 – 25% CO_2
Temperature-responsive zero drift[b]	≤ ± 0.5% O_2	≤ ± 0.5% CO_2
Temperature-responsive span drift[b]	≤ ± 0.5% O_2	≤ ± 0.5% CO_2
Response time (95%)	≤ 200 seconds	≤ 200 seconds
Cycle time	≤ 15 minutes	≤ 15 minutes

[a] Unlike gas analysers, a specific span is designated for dilution analysers. The requirements, therefore, are not based on "x per cent of span", but are based on the actual O_2 and CO_2 readings. For example, the Lower Detection Limit of ≤ 0.5% O_2 simply means the analyser must be able to detect 0.5% or less of O_2; it does not mean it has to detect 0.5% of the span value of 21% O_2.
[b] For every 10°C change in analyser operating temperature within the ambient range of 5°C to 35°C.

1.1.4 Design Specifications for In-stack Opacity Monitors

In-stack opacity monitors (and the affiliated system, as applicable) must satisfy the design specifications in Table 4.

Table 4: Design specifications for in-stack opacity monitors

Design Specification	In-Stack Opacity Monitors
Spectral response	Photopic
Angle of view	≤ 4°
Angle of projection	≤ 4°
Peak and mean spectral response	500 nm–600 nm
Spectral response at below 400 nm or above 700 nm	≤ 10% of peak spectral response
Monitor span	0–100%
Temperature-responsive zero drift[a]	≤ ± 2% opacity
Temperature-responsive span drift[a]	≤ ± 2% opacity
Response time (95%)	≤ 10 seconds
Compensation for dirt accumulation (on windows)	≤ 4°
Physical design[b]	a. simulated zero and upscale calibration system b. access to external optics

Design Specification	In-Stack Opacity Monitors
	c. automatic zero compensation d. external calibration filter access e. optical alignment sight f. path length correction factor security g. accuracy of data is not affected by fluctuations in supply voltage, ambient temperature, and ambient light over the range specified by the manufacture
[a] For every 10°C change in analyser operating temperature within the ambient range of 5°C to 35°C. [b] Physical design requirements are further detailed in the Cod. Alternatively, a certificate of conformance from the manufacturer stating that the in-stack opacity monitor meets the design specifications of the USEPA given in 40 CFR 60 Appendix B – Performance Specification 1, would be acceptable.	

1.1.5 Design Specifications for Volumetric Flow/Velocity Monitors

Volumetric flow/velocity monitors (and the affiliated system, as applicable) must satisfy the design specifications in Table 5.

Table 5: Design specifications for volumetric flow/velocity monitors

Design Specification	Flow Monitors
Lower detection limit	≤ 1.0 m/sec
Monitor span	≥ 1.5 times expected maximum value
Response time (95%)	≤ 10 seconds
Physical design[a]	a. means of cleaning flow element b. no interference from moisture
[a] Physical design requirements are further detailed in this Guideline.	

1.1.6 Design Specifications for Temperature Monitors (Sensors)

Temperature monitors/sensors (and the affiliated system, as applicable) must satisfy the design specifications in Table 6.

Table 6: Design specifications for temperature monitors (sensors)

Design Specification	Temperature Monitors (Sensors)
Monitor (sensor) span	≥ 1.5 times licence limit
Response time (95%)	≤ 60 seconds

2. PHASE II – INSTALLATION REQUIREMENTS

2.1 Installation Specifications

2.1.1 Location of the Sampling Site

CEMS are to be sited in a location and in such an orientation such that:

a) the measurements obtained are representative of the actual emissions;
b) effluent gases are well-mixed; and
c) it is accessible at all times (in accordance with safety regulations) and during any normal weather conditions.

2.1.2 Measurement Sampling Plane Location

The measurement sampling plane location shall be:

a) at least two equivalent internal diameters downstream from the nearest control device, the point of pollutant generation, or other point at which a change in the pollutant concentration or emission rate may occur (except for opacity monitors, which must be located a minimum of four diameters downstream from particulate control equipment or flow disturbances); and
b) at least a half equivalent internal diameter upstream from the effluent exhaust or control device (except for opacity meters which must be located at least two duct diameters upstream of a flow disturbance).

Figure 2 provides a visual representation of the measurement sampling plane location.

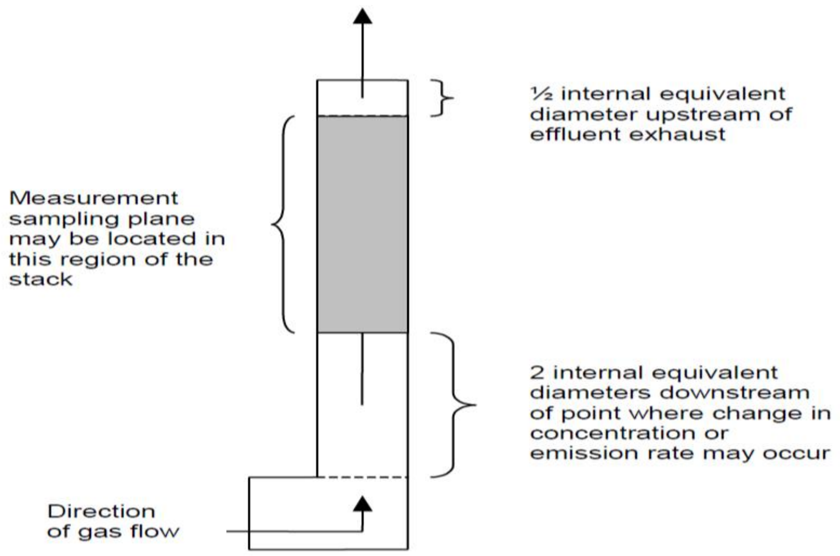

Figure 1: Measurement sampling plane location

2.1.3 Measurement Point Location

The measurement point shall be:

a) no less than 1.0 metre from the stack or duct wall; or
b) within or centrally located over the centroidal area of the stack or duct cross-section.

Variation from these requirements is permissible provided the Performance Specifications are satisfied for the monitoring system in question.

Figure 3 provides a visual representation of measurement point location.

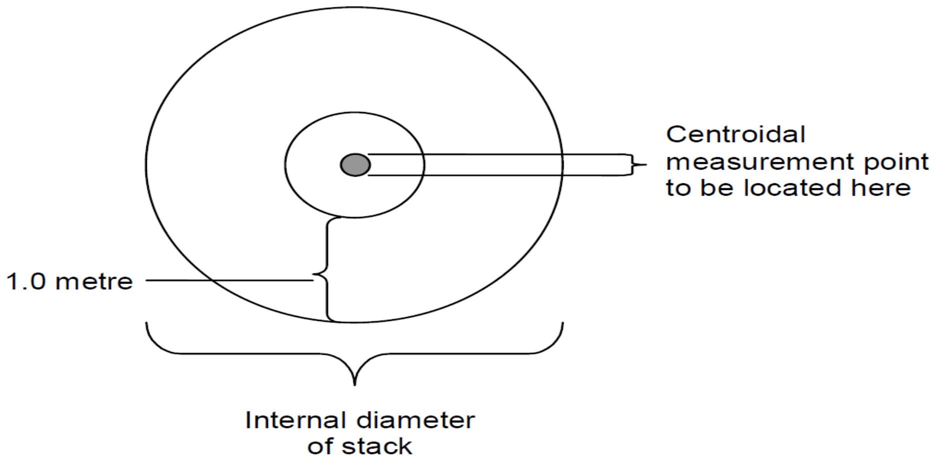

Figure 3: Measurement point location

2.1.4 Path In-situ Monitors

The measurement path shall:

a) exclude the area bounded by a line 1.0 metre from the stack or duct wall; or
b) have at least 70 per cent of the path within the inner 50 per cent of the stack or duct cross-stanal area; or
c) be centrally located over the centroidal area.

Figure 4 provides a visual representation of the measurement path for path in-situ monitors.

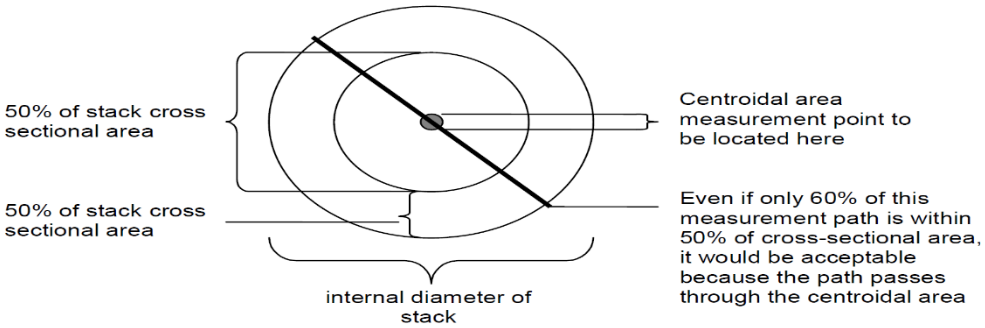

Figure 4: Path in-situ monitors

3. PHASE III – PERFORMANCE ASSESSMENT

3.1 Performance Specifications

3.1.1 Performance Specifications for Sulphur Dioxide, Oxides of Nitrogen, and Carbon Monoxide Monitoring Systems

Sulphur dioxide, oxides of nitrogen, and carbon monoxide emission monitoring systems must satisfy the performance specifications in Table 7.

Table 7: Performance specifications for sulphur dioxide, oxides of nitrogen, and carbon monoxide monitoring systems Performance

Performance Specifications	Sulphur Dioxide Systems[a]	Oxides of Nitrogen Systems[a]	Carbon Monoxide Systems[a]
Zero drift – 24-hour	≤ ± 2.5 %	≤ ± 2.5 %	≤ ± 5 %
Span drift – 24-hour	≤ ± 2.5 %	≤ ± 2.5 %	≤ ± 5 %
Response time (95%)	≤ 200 seconds	≤ 200 seconds	≤ 200 seconds
Cycle time	≤ 15 minutes	≤ 15 minutes	≤ 15 minutes
Analyser linearity	≤ 5.0 % linearity error, or ± 5 ppmv from the reference gas value	≤ 5.0 % linearity error, or ± 5 ppmv from the reference gas value	≤ 5.0 % linearity error, or ± 5 ppmv from the reference gas value
Relative accuracy[b]	≤ ± 20 %	≤ ± 20 %	≤ ± 10 %
Bias	≤ 2 %	≤ 2 %	≤ 2 %

a Where two limits are given in the table, whichever value is greater is the applicable limit.

b If the arithmetic mean of the Reference Method (RM) values is less than 50% of the licence condition limit then for SO2, NOx, and CO it is acceptable if the CEMS is within ± 10% of span value, as compared to the RM. For example, let the Reference Method result be 125 mg/m3. If the span is 0 – 500 mg/m3, then the RM result is less than 50% of full scale (125 mg/m3 < 250 mg/m3). Therefore, to satisfy the relative accuracy requirement, the CEMS must only be within 10% of full scale, or ± 50 mg/m3 from the RM (i.e. 125 mg/m3 + 50 mg/m3). This allows greater flexibility for facilities with well-controlled processes, which would otherwise have to meet the requirement of 10% of RM value (in the prior example, this would be 125 mg/m3 ± 12.5 mg/m3).

3.1.2 Performance Specifications for Total Reduced Sulphur and Hydrogen Sulfide Monitoring Systems

Total reduced sulphur and hydrogen sulfide monitoring systems must satisfy the performance specifications in Table 8.

Table 8: Performance specifications for total reduced sulphur and hydrogen sulfide monitoring systems

Performance Specifications	Total Reduced Sulphur Systems[a]	Hydrogen Sulfide Systems[a]
Zero drift – 24-hour	*≤ ± 5 %*	*≤ ± 5 %*
Span drift – 24-hour	*≤ ± 5 %*	*≤ ± 5 %*
Response time (95%)	*≤ 200 seconds*	*≤ 200 seconds*
Cycle time	*≤ 15 minutes*	*≤ 15 minutes*
Analyser linearity	*≤ ±5 %*	*≤ ± 5 %*
Relative accuracy	*≤ ±20 %, or ≤ ±2 ppmv from the reference gas value*	*≤ ±20 %, or ≤ ± 2 ppmv from the reference gas value*
Bias	*≤ 2 %*	*≤ 2 %*

[a] Where two limits are given in the table, whichever value is greater is the applicable limit.

3.1.3 Performance Specifications for Oxygen and Carbon Dioxide Monitoring Systems

Oxygen and carbon dioxide monitoring systems must satisfy the performance specifications in Table 9.

Table 9: Performance specifications for oxygen and carbon dioxide monitoring systems

Performance Specifications	Oxygen Monitors[a]	Carbon Dioxide Monitors[a]
Zero drift – 24-hour	*< + 0.5 % O_2 from the reference gas value*	*< + 0.5 % CO_2 from the reference gas value*
Span drift – 24-hour	*< + 0.5 % O_2 from the reference gas value*	*< + 0.5 % CO_2 from the reference gas value*
Response time (95%)	*< 200 seconds*	*< 200 seconds*
Cycle time	*< 15 minutes*	*< 15 minutes*
Analyser linearity	*< 5.0 % linearity error or < + 0.5 % O_2 from the reference gas value*	*< 5.0 % linearity error or < + 0.5 % CO_2 from the reference gas value*
Relative accuracy	*< + 10.0 %, or < + 1 % O_2 from the reference gas value*	*< + 10.0 %, or < + 1 % CO_2 from the reference gas value*
Bias	*< 2 %*	*< 2 %*

[a] *Where two limits are given in the table, whichever value is greater is the applicable limit.*

3.1.4 Performance Specifications for in-stack Opacity Monitoring Systems

In-stack opacity monitors must satisfy the performance specifications in Table 10.

Table 10: Performance specifications for in-stack opacity monitors

Performance Specifications	In-Stack Opacity Monitors
Zero drift – 24-hour	≤ ± 2 % In-stack opacity
Span drift – 24-hour	≤ ± 2 % In-stack opacity
Response time	≤ 10 seconds

3.1.5 Performance Specifications for Volumetric Flow/Velocity Monitoring Systems

Flow monitors must satisfy the performance specifications in Table 11.

Table 11: Performance specifications for volumetric flow/velocity monitors

Performance Specifications	Volumetric Flow/Velocity Monitors
Zero drift – 24-hour	≤ ±3 %
Span drift – 24-hour	≤ ± 3 %
Response time (95%)	≤ 10 seconds
Orientation sensitivity	≤ ± 4 %
Relative accuracy	≤ ± 20 %

3.1.6 Performance Specifications for Temperature Monitors (Sensors)

Temperature sensors must satisfy the performance specifications in Table 12.

Table 12: Performance specifications for temperature monitors (sensors)

Performance Specification	Temperature Monitors (Sensors)
Response time (95%)	≤ 60 seconds
System relative accuracy	± 10°C of the temperature values obtained during conduct of a RATA

3.1.7 Other Monitors

Other monitors not specified elsewhere must satisfy the following requirements:

- response time (95%) < 200 seconds;
- cycle time ≤ 15 minutes; and
- calibrations and maintenance must be performed as per manufacturer specifications/recommendations.

APPENDIX: REFERENCES FOR THIS DOCUMENT

Abu Dhabi Law No. (16) of 2005 about Establishment of the Environment Agency–Abu Dhabi (EAD).

Alberta Environmental Protection. 1998*. Continuous Emission Monitoring System (CEMS) Code*. Edmonton, Alberta, Canada.

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U. S. Environmental Protection Agency. 2003. *Code of Federal Regulations: Standards of Performance for New Stationary Sources (Continued). Appendix B - Performance Specifications.* 40 CFR 60 Appendix B. Washington, D.C.