Performance Standard for Handheld Emission Monitoring Systems (HEMs)

Performance standard for stack emission monitoring, fugitive emissions, and landfill-gas bore-hole emissions

Environment Agency
Version 4
September 2018

Foreword

The Environment Agency established its Monitoring Certification Scheme (MCERTS) to ensure environmental measurements meet our requirements for suitability and quality. MCERTS covers the product certification of monitoring systems, the competency certification of personnel, the accreditation of laboratories and the provision of third party inspection services.

This document specifies the performance characteristics and test procedures for handheld emission monitoring systems (referred to as HEMs). HEMs are instruments that are used to make measurements in a wide variety of applications when the user needs a high degree of portability. For example, stack emissions monitoring for indicative purposes, monitoring some plants that fall under the Medium Combustion Plant Directive (MCPD), fugitive emissions and gaseous releases from landfill bore-holes. HEMs would typically be simpler and have a higher measurement-uncertainty than continuous emission monitoring systems (CEMs).

HEMs differ from the transportable variants of CEMs, known as transportable CEMs (T-CEMs), which are designed to perform to the same high standards as required for CEMs. T-CEMs are suitable for quantitative measurements and verifying and calibrating CEMs. T-CEMs are typically designed to meet or exceed the uncertainty requirements specified in the Industrial Emissions Directive (IED), under the requirements for installations that fall under Chapters III and IV of the IED, i.e. large combustion plants and incinerators respectively. The specifications for CEMs and T-CEMs, referred to as transportable systems are included in the *MCERTS Performance Standards and Test Procedures for Continuous Emission Monitoring Systems (CEMs) and Transportable-CEMs (T-CEMs).*

The benefits of this standard for HEMs are that it:

- provides confidence to regulatory authorities that handheld systems, once certified, are fit for purpose and capable of producing results of the required quality and reliability
- provides confidence to users that the handheld system selected is robust and meets performance standards that are accepted by the Environment Agency
- supports the supply of accurate and reliable data to the public
- provides instrument manufacturers with an independent authoritative endorsement of their products, which will improve their access to international markets and increase the take-up of their products in the UK

The performance requirements described in this document are based on relevant sections of a number of international ISO or CEN standards, as well as taking into account other relevant national standards.

If you have any questions about the how the certification process works, or you would like more information on how to apply, please contact CSA-Group using the details below.

Sira Certification Service
CSA Group
Unit 6 Hawarden Industrial Park
Hawarden
CH5 3US

Phone: +44-1244 670 900
E-mail: ukinfo@csagroup.org

If you have any general questions about MCERTS, please contact us.

Email: enquiries@environment-agency.gov.uk

Tel: +44 (0) 3708 506 506

You can get more information on MCERTS, including the standards related to CEMs, from our website at www.mcerts.net.

Record of Amendments

Version number and date		Amendment
Version 3.1	5, performance requirements	Performance characteristic for landfill monitors amended: - Ambient temperature amended - H_2S response time added - Table A1.2 – CO concentration amended.
V 4.0	Foreword	Distinction between the different types of emissions-monitoring systems.
V 4.0	1.1 Background	Updating reference for MCERTS standards for CEMs and T-CEMs
V 4.0	1.6. Previous performance-tests	New sub-section
V 4.0	2, References	Removal of EN 15267-3 and addition of EN 15267-4. Addition of EN 15446.
V 4.0	3.3, Classification of instruments	New sub-section
V 4.0	4, Definitions	Two new definitions added: threshold concentration and calibration precision
V 4.0	5, Performance requirements	Separation of requirements for fugitive-emissions monitoring-systems moved to a separate sub-section (5.3) and aligned with the requirements of EN 15446.

Contents

Performance Standard for Handheld Emission Monitoring Systems

1 Introduction

1.1 Background

1.1.1 The Environment Agency established the Monitoring Certification Scheme (MCERTS) to deliver environmental measurements that meet our requirements for suitability and quality.

1.1.2 This document specifies the performance characteristics and test procedures for handheld emission monitoring systems (referred to as HEMs in the remainder of this document). The determinands covered include, but are not restricted to:

- sulphur dioxide (SO_2)
- oxides of nitrogen (principally NO and NO_2, but also N_2O)
- carbon monoxide (CO) and carbon dioxide (CO_2)
- hydrogen chloride (HCl)
- hydrogen fluoride (HF)
- methane (CH_4)
- sulphur hexafluoride (SF_6)
- hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs)
- mercury (Hg)
- formaldehyde
- benzene
- volatile organic compounds, expressed as total organic carbon (TOC)
- oxygen (O_2)
- water vapour (H_2O)
- flow rate

1.1.3 HEMs are instruments that are used to make measurements in a wide variety of applications, for example, stack emissions monitoring for indicative purposes, monitoring some plants that fall under the MCPD, fugitive emissions and gaseous releases from landfill bore-holes.

1.1.4 Some transportable emission-monitoring systems are variants of continuous emission monitoring systems (CEMs), designed to perform to the same high standards as required for CEMs. These systems are not covered by this standard. The specifications for these systems, referred to as transportable CEMs (T-CEMs), are included in the *MCERTS Performance Standards and Test Procedures for Continuous Emission Monitoring Systems (CEMs) and Transportable-CEMs (T-CEMs).*

1.1.5 The general requirements and performance characteristics for HEMs are included in section 4. The test procedures are included in EN 15267: Part 4. This standard has been applied through the *MCERTS Performance Standards and Test Procedures for Continuous Emission Monitoring Systems (CEMs) and Transportable-CEMs (T-CEMs).*

1.2 Testing and certification

1.2.1 HEMs shall undergo testing either by a laboratory acceptable to the Certification Body or alternatively, manufacturers may carry out in-house testing, if the Certification Body is satisfied that the test facilities of the manufacturer meet the applicable requirements for quality assurance. Manufacturers may also choose to

use a combination of both external and in-house testing.

1.2.2 When manufacturers wish to carry out in-house testing, they should describe their test facilities to the Certification Body, including provisions for quality assurance and quality control of testing, and indicate which tests manufacturers wish to perform themselves.

1.2.3 If a manufacturer carries out in-house testing, then the results of the tests will be subject to audit and supervision by the Certification Body. The audit will examine the test methods, test results and traceability.

1.2.4 When applying for certification, manufacturers shall state the determinands measured, ranges and intended process applications. The performance data from testing may indicate that the possible range for each determinand may be greater or less than the nominated range. As lower ranges indicate better performance, manufacturers may elect to have a lower range based on the test results.

1.2.5 Manufacturers may have had some tests already performed. If so, then the manufacturer should include any applicable test reports with the application for certification. When some or all testing has already been carried out, the Certification Body will decide if any further tests are required and then agree with the manufacturer whether any such supplementary tests are to be performed using the manufacturers own test facilities or at third-party test laboratories.

1.3 Unique identification of HEMs

1.3.1 HEMs shall have a unique designation that unambiguously identifies the equipment as a certified model.

1.3.2 Any changes in the design that have an effect on the performance of the handheld system must be reflected in the unique designation of the system.

NOTE: For example, a handheld system that has been modified shall be given a new model designation or number to distinguish it clearly from previous models.

1.4 Repairs, maintenance and modifications to certified HEMs

1.4.1 Any spares or replacement parts for certified HEMs shall meet the same performance standards as the original parts. Operators and equipment suppliers may be required to provide evidence that the replacement parts meet the required performance standards of the original equipment as specified by the manufacturer.

1.4.2 Modifications to certified HEMs are allowable so long as manufacturers can demonstrate that these design changes do not degrade the performance of the handheld system below the MCERTS performance standards.

1.4.3 Manufacturers shall keep detailed records and drawings of all design changes to HEMs, and have provisions for design verification, inspection and testing to ensure that the HEMs still meet the required performance standards. The requirements for a manufacturer's quality management system are described in Section 6 of this document.

1.4.4 The Certification Body will conduct audits of the design changes to handheld standards to meet the requirements of product certification. Manufacturers shall notify the Certification Body of any modifications to equipment that may have a significant effect on the performance of the handheld system.

1.4.5 Design modifications or extensions to the range of application of a handheld system may require renewed testing. The extent of this renewed testing will depend upon the nature of the modifications to the handheld system.

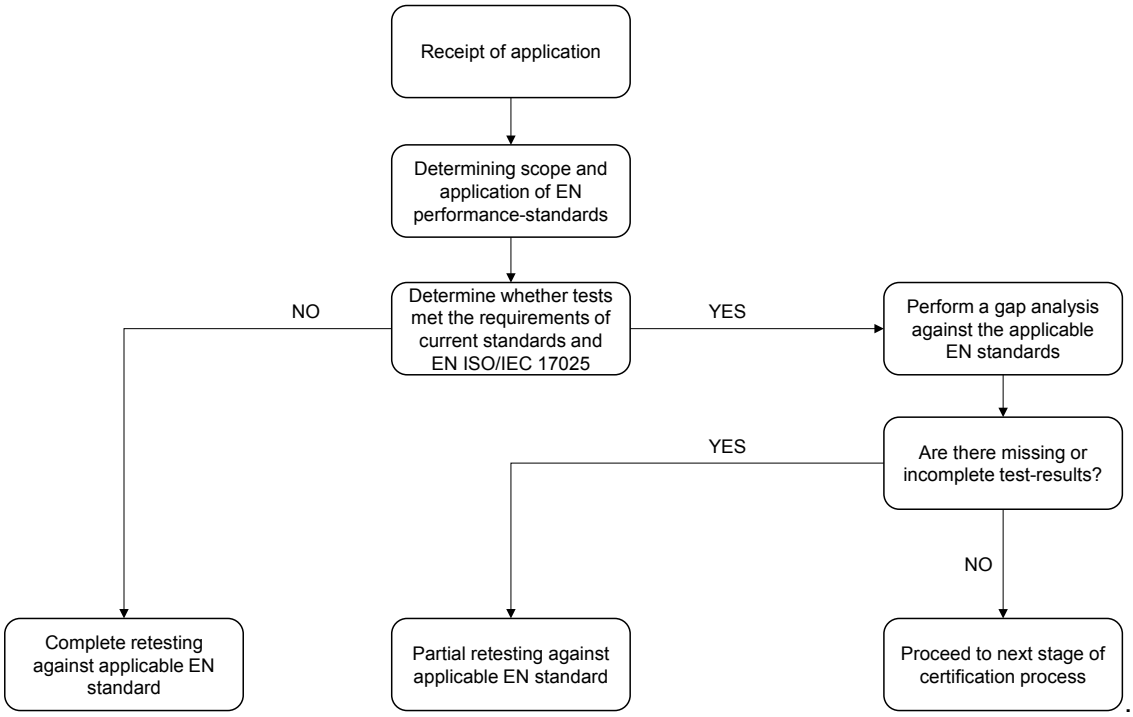
1.4.6 If there is evidence that a modification has only limited effects on the performance of the handheld system, then it would not be necessary to retest a handheld system completely. In such cases, only a supplementary test would be required.

1.4.7 In the case of modifications to software, documentation must be presented to the Certification Body indicating the nature of the modification as well as resultant effects on operation and functionality. The Certification Body will then decide if any further testing is required.

1.5 Previous performance-tests

Manufacturers that have test reports already to demonstrate compliance with other requirements, for example. Manufacturers are encouraged to submit existing test-data for HEMs. Figure 1 shows the process by which the Certification Body assesses existing test-data.

Figure 1 – Process for the assessment of existing test-data



1.6 Certificate validity

1.6.1 MCERTS certificates are valid for five years, after which the certification is reviewed against the current MCERTS performance standard. Any necessary retesting will be identified to maintain the certification.

2 References

Performance Standards and Test Procedures for Continuous Emission Monitoring Systems (CEMs) and Transportable-CEMs (T-CEMs), Version 4, July 2018. Environment Agency

EN ISO 9001:2015, Quality management systems – Requirements.

EN 15267-2:2009, Air quality - Certification of automated measuring systems - Part 2: Minimum requirements for product quality assurance, initial assessment and on-going surveillance.

EN 15267-4:2017, Air quality — Certification of automated measuring systems — Part 3: Performance criteria and test procedures for automated measuring systems for periodic measurements of emissions from stationary sources.

EN 15446:2008, Fugitive and diffuse emissions of common concern to industry sectors. Measurement of fugitive emission of vapours generating from equipment and piping leaks.

3 Scope

3.1 Scope of MCERTS for handheld emission monitoring systems

The scope covers HEMs designed to monitor:

- indicative stack emissions monitoring
- monitoring some installations that fall under the MCPD
- fugitive emissions, for example, from pipe-work
- landfill gas emissions

HEMs have a less demanding set of specifications than those for CEMs and T-CEMs. Therefore HEMs may be used for lower-risk installations, such as the smaller combustion plants that fall under the MCPD (see next section). As such, the different types of HEMs complement CEMs and T-CEMs, which are used for higher-risk installations, such as those regulated under Chapters III (Large Combustion Plants) and Chapter IV (Incineration and Co-incineration Plants) of the IED.

3.2 Classification for instruments used to measure emissions from small, medium and large combustion plants

Combustion plants range in size, typically expressed as thermal-input capacity, ranging from kilo-Watts (kW), through to mega-Watts (MW) and giga-Watts (GW). Combustion plants regulated by the Environment Agency, either as stand-alone installations or as an associated process within an installation, range from several hundred kW in capacity, up to a few GW for the very largest power stations.

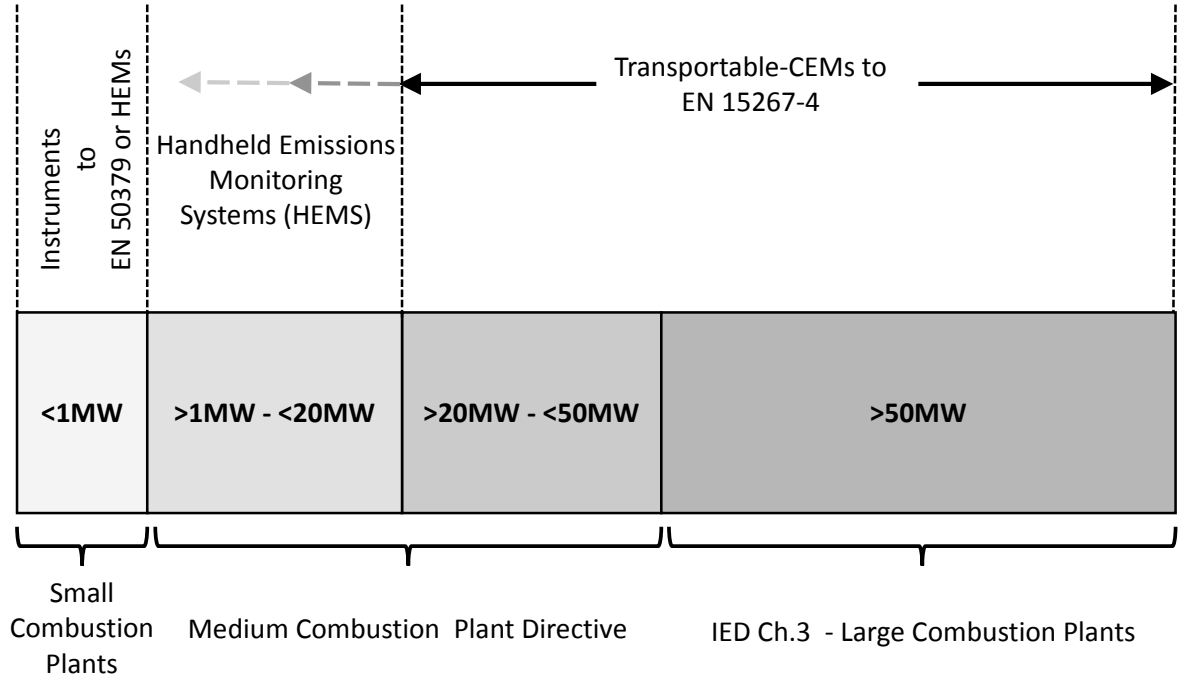
The Environment Agency regulates combustion plants from 1MW to 50MW under the MCPD and from 50MW upwards under the provisions for large combustion-plants (LCPs) under the provisions of Chapter III of the Industrial Emissions Directive (IED).

HEMs typically have a role in measuring emissions from combustion plants up to 20MW in capacity; T-CEMs typically have a role for installations over 20MW, whilst

CEMs are normally used at installations above 100MW. However, CEMs, T-CEMs and HEMs have overlapping roles and applications depending on the process size (thermal input) and type of fuel.

Figure 2 shows the spectrum of combustion plants rated by thermal-input capacity, the legislation that applies to them, and the potential application of CEMs, T-CEMs and HEMs across the range of sizes of combustion plants.

Figure 2 – Application of HEMs, T-CEMs and CEMs at combustion plants



4 Definitions

4.1 calibration precision
the degree of agreement between several measurements of the calibration gas with the same known concentration

4.2 certification range
range over which the handheld system is tested and certified for compliance with the relevant performance criteria

4.3 cross-sensitivity
response of the handheld system to interferents

4.4 interference
negative or positive effect that a substance has upon the output of the handheld system, when that substance is not the measured component

4.5 lack of fit (linearity)
systematic deviation, within the range of application, between the accepted value of a reference material applied to the measuring system and the corresponding result of the measurement produced by the calibrated measuring system

4.6 output
reading, or digital or analogue electrical signal generated by a handheld system in response to a measured object

4.7 performance characteristic
quantity assigned to a handheld system in order to define its performance

4.8 repeatability
ability of a handheld system to provide closely similar indications for repeated applications of the same measurand under the same conditions of measurement

4.9 response time, T_{90}
time interval between the instant of a sudden change in the value of the input quantity to a handheld system and the time as from which the value of the output quantity is reliably maintained above 90% of the correct value of the input quantity

4.10 span point
value of the output quantity (measured signal) of the handheld system for the purpose of calibrating, adjusting etc. that represents a correct measured value generated by reference material between 70% and 90% of the range tested

4.11 threshold concentration
the pre-set performance target for the individual sources

4.12 zero point
specified value of the output quantity (measured signal) of the handheld system and which, in the absence of the measured component, represents the zero crossing of the handheld system characteristic

NOTE: In the case of oxygen and some flow monitoring handheld systems, the zero point is interpreted as the lowest measurable value

4.13 span drift
change in handheld system reading at the span point over a stated period of unattended operation

4.14 zero drift
change in handheld system reading at the zero point over a stated period of unattended operation

4.15 Zero gas
gas mixture used to establish the zero point of a calibration curve when used with a given analytical procedure within a given calibration range

5 Requirements, performance characteristics and test methods

5.1 General requirements

5.1.1 HEMs shall have an indicator to show the measured parameter(s) and value.

5.1.2 HEMs shall have an output of at least –5% to +105% of the certification range.

NOTE: This is to provide for a living zero reading, which means that the instrument can indicate both positive and negative drift. This requirements does not apply to oxygen monitors which use

Zirconia sensors.

5.1.3 When the HEM is provided with a printer, the printer output for each set of data will include a record of the date, time and value of all the specified measurement parameters.

5.1.4 The HEM shall be equipped with a security mechanism to prevent inadvertent and unauthorised adjustment

NOTE: Security mechanisms can include a key or security code programmed in to the handheld system before adjustments are permitted

5.1.5 The HEM shall comply with all applicable EC Directives.

5.1.6 Any sampling system will be so constructed as to prevent damage to the sensor(s) and pump by particulate matter and liquids that may be expected in the application. Verification will be by inspection.

5.1.7 There are no performance characteristics for drop tests or vibration tests. However, if the handheld system has undergone such tests for other purposes, then this will be reported on the certificate.

5.2 Performance characteristics and test methods – HEMs for stack-emissions monitoring, landfill-gas monitors, oxygen and flow

5.2.1 Performance characteristics

Performance characteristics for HEMs other than those for fugitive emissions monitoring are shown in Table 1. The values for individual performance characteristics are expressed as a percentage of the certification range unless otherwise stated.

Table 1: Performance characteristics for HEMs

Performance characteristic	Stack emissions monitors	Landfill gas monitors	Oxygen[1]	Gas flow monitors	EN 15267-4 clause
Response time	<200s	<60s <90s H_2S	<200s	<60s	10.6
Repeatability at zero point	<±5%	<±5%	<±0.4%	-	10.7
Repeatability at span point	<±5%	<±5%	<±0.4%	<±5%	10.8
Lack-of-fit (linearity)	<±5%	<±5%	<±0.4%	<±5%	10.12
Influence of ambient temperature change from 20ºC within specified range at zero point	<±5%	<±10%	<±0.8% (<±1.5%)[2]	<±5%	10.11
Influence of ambient temperature change from 20ºC within specified range at span point	<±5%	<±10%	<±0.8% (<±1.5%)[2]	<±5%	10.11
Cross-sensitivity	<±5%	<±5%	<±0.8%	-	10.16
Zero drift (1 hour)	<±3%	<±3%	<±0.3%	-	10.10
Span drift (1 hour)	<±3%	<±3%	<±0.3%	-	10.10

NOTE 1: The performance specifications for oxygen apply to monitoring systems for stack emissions and landfill gas. The performance specifications are expressed as a percentage of volume concentration of oxygen.

NOTE 2: The performance specification for the effects of ambient temperature on landfill-gas monitoring-systems is <±1.5%.

5.2.2 Warm up time

The handheld system shall be switched off and left off for at least 24 hours in clean air. After the 24 hour period the handheld system shall be switched on and the time taken for the unit to indicate a stable reading shall be determined.

5.2.3 Response time

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.6.

5.2.4 Repeatability at zero point

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.7. The repeatability standard deviation at zero point shall be calculated based on at least 5 consecutive individual readings.

5.2.5 Repeatability at span point

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.8. The repeatability standard deviation at span point shall be calculated based on at least 5 consecutive individual readings.

5.2.6 Lack-of-fit (linearity)

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.12.

5.2.7 Influence of ambient temperature

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.11. The ambient temperature range is ordinarily +5^{o}C to +40^{o}C. The manufacturer may specify an alternative ambient temperature range. The ambient temperature range will be stated on the certificate.

5.2.8 Cross-sensitivity

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.16. Appropriate interferents (Table A1-1) shall be agreed between the manufacturer and the Certification Body. The sum total of positive deviations and the sum total of negative deviations will be specified individually identifying the actual magnitude. For landfill gas borehole monitoring systems, a test gas with the composition shown in Table A1-2 shall be used.

5.2.9 Zero and span drift

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.10.

5.3 Performance requirements for fugitive-emissions monitoring systems

5.3.1 Performance characteristics

Table 2: Performance characteristics for Fugitive Emissions Monitoring Systems

Performance characteristic	Specification	EN 15446 Test-clause	EN 15267-4 Test-clause
Detection limit	10ppm		10.7
Range	0-50,000ppm+		10.3
Scale resolution of threshold concentration[1]	±5%		
Flow rate	0.2 to 1.2 $l.min^{-1}$		10.15
Response time[2]	<5s	A.1	
Response factors[2]	<10	A.3	
Calibration precision[2,3]	±10%	A.2	

Note 1: The threshold concentration is the pre-set performance target for the individual sources.

Note 2: If the instrument is to be certified for quantification purposes rather than simply leak-detection, then these performance characteristics also apply.

Note 3: The calibration precision is the degree of agreement between several measurements of the calibration gas with the same known concentration.

5.3.2 Classes of compound detected

The manufacturer shall state the classes of compounds that the instrument detects.

A manufacturer may use any type of suitable detector. For example catalytic oxidation, flame ionisation, infrared absorption, and photo ionisation.

5.3.3 Pump

The instrument must be equipped with a pump that provides a continuous sample to the instrument-detector.

5.3.4 Probe

The instrument shall be equipped with a sampling-probe or probe extension for that has a maximum outside-diameter of 6.4 mm. The probe or extension shall have a single end-opening for taking the sample.

5.3.5 Intrinsic safety

The instrument shall be intrinsically safe for operating in explosive atmospheres.

5.3.6 Warm up time

The handheld system shall be switched off and left off for at least 24 hours in clean air. After the 24 hour period the handheld system shall be switched on and the time taken for the unit to indicate a stable reading shall be determined.

5.3.7 Detection limit

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.7, using the test for the repeatability at zero as a means of determining the detection limit.

The test laboratory shall then administer a test gas at a concentration of 10ppm, in order to confirm that the instrument responds accordingly. This test shall be repeated three times and an average result calculated.

5.3.8 Range

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.3.

5.3.9 Flow rate

The test shall be carried out generally in accordance with the requirements of EN 15267-4, Clause 10.15

5.3.10 Response time

The test shall be carried out to the requirements of EN 15446, Annex A, test A.1.

5.3.11 Calibration precision

The test shall be carried out generally in to requirements of EN 15446, Annex A, test A.2.

6 Manufacturer's quality system

6.1 The manufacturer shall have a quality system in place that complies with the requirements of ISO 9001 and the supplementary requirements of EN 15267-2.

6.2 The manufacturer shall have an annual audit managed by the Certification Body. The purpose of this audit is not to repeat the elements which are assessed during routine ISO 9001 certification and surveillance visits, but to cover the requirements of MCERTS above and beyond those of ISO 9001, i.e. the supplementary requirements of EN 15267-2.

The audit will include an evaluation of the provisions for:

- the management and control of the design change process
- manufacturing (process control), final inspection tests and calibration - to ensure reproducibility
- unambiguous identification of MCERTS certified equipment
- assuring that design changes do not degrade instrument performance such that instruments no longer meet the MCERTS performance standards

6.3 Manufacturers shall inform the Certification Body of any design changes to the handheld system. The Certification Body will then decide if the current certificate is still valid, or if further testing is required to ensure the performance specification is still within the MCERTS Standard.

7 Status of this document

This MCERTS Standard may be subject to review and amendment following publication. The latest version is available on the Agency's website at www.mcerts.net

Appendix 1: Standard gas concentrations for cross-sensitivity testing

A1.1 Stack emissions monitoring systems

When determining cross-sensitivity of stack emission monitoring systems, the following concentrations of interferents shall be used. The concentrations may need to be changed depending on the measuring technique, the type of system involved and the intended application. The interferents shall be admitted individually.

Table A1-1: Recommended minimum concentrations of interferents

interferent	Concentration	Unit
O_2	3 and 21	%
H_2O	30	%
CO	300	mg/m^3
CO_2	15	%
CH_4	50	mg/m^3
N_2O	20	mg/m^3
NO	300	mg/m^3
NO_2	30	mg/m^3
NH_3	20	mg/m^3
SO_2	200	mg/m^3
SO_2 (coal-fired power stations without desulphurisation)	1000	mg/m^3
HCl	50	mg/m^3
HCl (coal-fired power stations)	200	mg/m^3

A1.2 Landfill bore-hole emissions monitoring systems

When determining the cross-sensitivity of landfill bore-hole monitoring systems, the following concentrations of interferents shall be used: The interferents shall be admitted collectively.

Table A1-2: Interferent concentrations for testing landfill-gas bore-hole monitoring systems

Interferent	Concentration
CO_2	48%
CH_4	48%
CO	70 mg/m^3
H_2S	20 mg/m^3
N_2	balance

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