



Performance Standards and Test Procedures for Automatic Isokinetic Samplers

**Environment Agency
Version 3
September 2016**



Record of amendments

Version Number	Date	Section	Amendment
2.1	Sept 2011	General	Includes some minor changes that update reference standards, references and contact details.
		Definitions	Removal of terms not mentioned in the text
3	Sept 2016	Foreword	Updated contact details for CSA
		2.1	Added reference to IED
		3.1	Replaced EN 45011 with EN ISO 17065
		3.2	Replaced ISO 10780 with BS EN ISO 16911-1

Status of this document

This document may be subject to review and amendment following publication. The latest version is available on our website at www.mcerts.net

If you have any general questions about this document, please contact Rupert Standing at rupert.standing@environment-agency.gov.uk

Foreword

The Environment Agency established its Monitoring Certification Scheme (MCERTS) to deliver environmental measurements that 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 contains the performance standards for automatic isokinetic samplers used in the measurement of emissions from industrial chimney stacks, flues and ducts. The performance standards are based on the relevant sections of a number of international ISO or CEN standards and take into account other relevant national standards.

MCERTS for automatic isokinetic samplers:

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

There are two types of isokinetic samplers covered by MCERTS:

- periodic automatic isokinetic samplers
- continuous automatic isokinetic samplers

Periodic isokinetic samplers are used in conjunction with the dust sampling trains and wet chemical sampling trains operated in accordance with relevant monitoring standards. Continuous isokinetic samplers are mainly used for continuous sampling of dioxins and PCBs over extended time periods.

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

CSA Group
Unit 6 Hawarden Industrial Park
Hawarden
Deeside
CH5 3US

Phone: +44(0)1244 670 900
E-mail: ukinfo@csagroup.org

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Performance standards for automatic isokinetic samplers

1 Introduction

1.1 Background

- 1.1.1 This document specifies the MCERTS Performance Standards for automatic isokinetic samplers for the measurement of pollutant emissions under isokinetic conditions. Two types of automatic isokinetic samplers are covered: periodic samplers - normally used with manual sampling trains for the collection of various species and continuous samplers - used for the collection of an integrated long term sample of, for example, dioxins and furans.
- 1.1.2 Performance standards are given for a number of system characteristics that relate to the isokinetic sampling of pollutants. The subsequent off-line analysis stage of the collected species is not included as this is outside the remit of the automatic sampler.
- 1.1.3 A combination of laboratory and field-testing is used to assess:
- accuracy and linearity of isokinetic sampling rate in response to changes in flue gas velocity
 - minimum operating (flue gas) velocity
 - response time to step changes in flue gas velocity
 - flow repeatability and short term drift under laboratory conditions
 - susceptibility to physical disturbances
 - environmental conditions
 - suitability of construction materials
 - flow reproducibility under field conditions
 - availability under field conditions (for continuous automatic isokinetic sampling systems)
 - accuracy of sample volume collected under field conditions
- 1.1.4 The performance standards for automatic isokinetic samplers are presented in Sections 5 and 6. Short explanations of the test procedures used to measure the performance characteristics are given in the Appendix.
- 1.1.5 Product certification comprises three stages. These are:
- Laboratory testing – used to determine performance characteristics, under strictly controlled conditions.
 - Field testing – the field test is carried out on processes representative of the intended industrial sectors and applications.
 - Assessment of test results and formal certification – which includes an audit of the manufacturing process to confirm that the manufacturer has provisions to ensure manufacturing reproducibility and to control any design changes to ensure that they do not degrade performance below the MCERTS standards.
- 1.1.6 Throughout this document, the terms “MCERTS certificate” and “certificate” refer to the “MCERTS product conformity certificate”.

1.2 Testing and certification

Testing

- 1.2.1 Automatic isokinetic sampling systems shall be tested either by an independent laboratory acceptable to the Certification Body or alternatively manufacturers may carry out in-house testing (subject to the requirements of paragraphs 1.2.3-5). Manufacturers may also choose to use a combination of both external and in-house testing.
- 1.2.2 Ideally, manufacturers should apply for certification before testing has been carried out, in which case the Certification Body will confirm the test programme.
- 1.2.3 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.
- 1.2.4 If a manufacturer carries out in-house testing, then the results of the tests will be subject to an external, independent audit by the Certification Body. This audit will examine the test methods, test results and traceability of the tests.
- 1.2.5 Manufacturers must keep a file of all test records for each designated automatic isokinetic sampling system and keep this file up-to-date for the lifetime of the certification.

Certification

- 1.2.6 When applying for certification, manufacturers must state the intended scope of certification, including operating ranges and intended process applications. Whilst manufacturers can nominate intended ranges, the performance data from testing may indicate that the certified range may be greater or less than the nominated range.
- 1.2.7 Manufacturers may have already had some tests performed. If so, the manufacturer should include any relevant test reports with the application for certification. The Certification Body will then decide if any further tests are required and agree with the manufacturer whether any such supplementary tests are to be performed using the manufacturer's own test facilities or at an independent laboratory.

1.3 Modifications to certified automatic isokinetic samplers

- 1.3.1 Modifications to certified automatic isokinetic samplers are allowable so long as manufacturers can demonstrate that these design changes do not degrade the performance of the sampler below the MCERTS performance standard.
- 1.3.2 Manufacturers must keep detailed records and drawings of all design changes to the certified sampler, and have provisions for design verification, inspection and testing to ensure that the sampler still meets the required performance standard.
- 1.3.3 The Certification Body will conduct a regular audit of the design changes to automatic isokinetic samplers to meet the requirements of product certification. Manufacturers must notify the Certification Body of any modifications to equipment that may have a significant effect on sampler performance.

NOTE: The audit frequency would typically be annually, but may be every two or three years depending on circumstances.

1.3.4 Design modifications or extensions to the range of application of a sampler may require renewed performance testing. The extent of this renewed testing will depend upon the nature of the modifications to the sampler. If there is evidence that a modification has only limited effects on performance, then it would not be necessary to retest the sampler completely.

1.3.5 In the case of modifications to software – detailed documentation (for example, source code) 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 further testing is required.

1.4 Certificate Validity

1.4.1 MCERTS certificates are valid for five years. Before expiry the certificate is reviewed for compliance with the current MCERTS standards and then any necessary retesting is identified to maintain certification.

2 Scope

2.1 The MCERTS scheme for automatic isokinetic samplers is particularly relevant to incineration, co-incineration and large combustion processes within the following Directive:

- 2010/75/EU, Directive on industrial emissions (integrated pollution prevention and control).

2.2 Automatic isokinetic samplers will ordinarily be tested on a large coal fired power station, municipal waste incinerator or a co-incineration cement kiln, depending on the intended application. The premise is that, if the sampler performs acceptably on these applications, then it is likely that it will perform well on the majority of less demanding processes. However, there will always be exceptions, and it is the responsibility of the manufacturer in conjunction with the user to ensure that the automatic isokinetic sampler will perform adequately on a specific process.

3 References

3.1 Normative references

- BS EN ISO/IEC 17025. General requirements for the competence of testing and calibration laboratories.
- EN ISO/IEC 17065:2012 - Conformity assessment – Requirements for bodies certifying products, processes and services

3.2 General references

- BS EN ISO 9169 (2006). Air Quality – Performance characteristics and related concepts for air quality measurements.
- ISO 9169 (2006). Air Quality – Determination of performance characteristics of measurement methods. Also Amendment 1 (CD)(1998).

- BS EN 13284-1:2002. Stationary source emissions - Determination of low range mass concentration of dust - Part 1: Manual gravimetric method.
- BS EN 50081-1 (1992). Electromagnetic compatibility. Generic Emission Standard. Residential, commercial and light industry.
- BS EN 50081-2 (1994). Electromagnetic compatibility. Generic Emission Standard. Industrial environment.
- BS EN 60359 (2002). Electrical and electronic measurement equipment - Expression of performance
- BS EN 16911-1: 2013. Stationary source emissions – Manual and automated determination of velocity and volume flow rate in ducts Part 1: manual reference method.

4 Definitions

Accuracy: The closeness of agreement between a single measured value of a determinand, and the true value (or an accepted reference value).

Availability: the fraction of the total monitoring time for which data/sample material of acceptable quality has been collected.

Certification range: The determinand values, over which the equipment is to be tested, bounded by specified upper and lower limits. Testing takes place within the certification range.

Delay time, T_{10} : The time taken for the output reading of the automatic isokinetic sampler to reach 10% of the total change in expected sampling rate.

Linearity: measure of fit of the automatic isokinetic sampler's performance across it's sampling range to a straight line, using a number of approximately equally distributed values of the flow velocity, and zero.

Performance characteristic: One of the quantities (described by values, tolerances, range) assigned to the automatic isokinetic sampler in order to define its performance.

Response time, T_{90} : The time taken for the gas flow velocity through the automatic isokinetic sampler probe to reach 90% of the total response.

5 General requirements

5.1 General requirements for automatic isokinetic samplers

5.1.1 The performance standards in this document apply to complete automatic isokinetic sampler systems, unless specified otherwise. Where manufacturers do not produce all of these components themselves, they should supply components from other manufacturers that they consider suitable for the required purpose(s).

5.1.2 Automatic isokinetic samplers shall conform to all applicable EC Directives. These include:

- Electro-Magnetic Compatibility Directive 2004/108/EC
- Directive 2006/95/EC (known as the Low-Voltage Directive) covering electrical equipment designed for use within certain voltage limits.

Automatic isokinetic sampler manufacturers or suppliers shall supply independently verifiable and traceable evidence of conformity to all the relevant Directives applicable to the equipment.

- 5.1.3 All automatic isokinetic samplers shall have a means of protection against unauthorised access to sampler control functions.
- 5.1.4 Automatic isokinetic samplers intended for continuous use shall have a means of connecting an additional indicating and recording device.
- 5.1.5 Automatic isokinetic samplers shall have a means of displaying their operating status, for example, normal operations, stand-by, maintenance mode, and malfunctions. Samplers intended for continuous use shall also have a means of communicating the operational status to a remote data collection system.
- 5.1.6 MCERTS certified automatic isokinetic samplers shall have a unique designation that unambiguously identifies the equipment as a certified model.

5.2 Certification range

- 5.2.1 The manufacturer shall specify and agree with the Certification Body the certification (velocity) range over which the isokinetic performance of the equipment is to be tested.
- 5.2.2 The range shall be chosen subject to the following considerations:
 - (a) The range will comprise a maximum and minimum (non-zero) value. The values must be fit for the purpose for the intended industrial application.
 - (b) Automatic functions shall not be adjusted in any way during the tests.
 - (c) If a manufacturer wishes to demonstrate performance over additional ranges further testing may be required.
 - (d) The MCERTS certificate will list all ranges certified, and will state explicitly the performance criteria tested for each range.

5.3 Unique identification of MCERTS certified samplers

- 5.3.1 MCERTS certified samplers shall have a unique designation that unambiguously identifies the equipment as a certified model.
- 5.3.2 MCERTS certified samplers shall have a means of showing the scope of certification. This could be an identification plate that shows the type, serial number, and the certified measurement ranges.
- 5.3.3 Any changes in the design that have an effect on the performance of the sampler must be reflected in the unique designation of the sampler.

6 Performance requirements

- 6.1 This section specifies the MCERTS performance requirements for both periodic and continuous automatic isokinetic samplers.
- 6.2 The values for the individual parameters given in these sections are expressed as a percentage of the relevant reading.

- 6.3 The performance requirements are presented in Tables 6.1, 6.2 and 6.3.
- 6.4 The reference values shall be determined by using velocity measurement standards and then calculating the volume.
- 6.5 The design of the automatic isokinetic sampling system shall be generally compliant with the requirements of the relevant standards for the intended application, for example, BS EN 13284-1, so that integration into a properly functioning system is achievable.

Table 6.1: Performance requirements for automatic isokinetic samplers (laboratory tests using a wind tunnel)

Flow Control Performance characteristic	Requirement
Velocity range	2-20 m s ⁻¹
Accuracy of isokinetic sampling rate response to changes in flue gas velocity	± 5%
Accuracy of determination of volume of gas sampled	± 2%
Linearity of isokinetic sampling rate	± 5%
Response time, T ₉₀ (seconds)	<100
Flow repeatability under laboratory conditions	±5 %
Minimum operational velocity±	2 m s ⁻¹
Drift (short term)	2%

Table 6.2: Performance standards for periodic automatic isokinetic samplers (field tests)

Performance characteristic	Requirement
Accuracy of the determination of volume of gas sampled assessed as a total over the sampling points within the traverses normally required by the relevant standards for specific duct geometry. This parameter is calculated as an average from ten testing runs.	± 5%
Flow reproducibility under field conditions calculated from the independent test results including all the points within the required traverses.	± 5%

Table 6.3: Performance standards for continuous automatic isokinetic samplers (field tests)

Performance characteristic	Specifications
Accuracy of the determination of volume of gas sampled calculated as an average of ten runs performed during the first or the last month of testing.	± 5%
Flow reproducibility under field conditions calculated from ten independent measurement results at one fixed location within the duct.	± 5%
Availability over three months continuous use	>95%

Appendix: Test Procedures

A1 Laboratory tests

The tests are presented in the approximate order they should be carried out in the laboratory.

Response (delay and rise) time

- A1.1 The delay time (T_{10}) is defined as the time taken for the sampler to reach 10 percent of the expected response, following introduction of a step change in sampling velocity. The response time (T_{90}) is defined as the time taken for equipment to reach 90 percent of the expected response, following introduction of the same step change. The rise time is defined as ($T_{90} - T_{10}$).
- A1.2 The above time shall be measured by introducing randomised step changes in the velocity at the input to the sampler. The size of each step shall be between 10 and 95 percent of the maximum of the certification range. The random sequence of steps will include both increased and decreased velocities and need not start from or end at zero.

Accuracy

- A1.3 The sampler shall be calibrated either in the factory or at the start of the laboratory tests using the manufacturer's instructions. This calibration must use the technique and any artefacts that are normally recommended by the manufacturer for this purpose. It is recommended that any calibration artefacts used by the manufacturer shall be traceable to national standards. The test laboratory may comment on the calibration technique where appropriate.
- A1.4 The isokinetic sampling accuracy of the equipment, together with the accuracy of the control of the volumetric sampling rate, when faced with different flue gas velocities shall be assessed using a wind tunnel. The measurement should be made using a reference instrument whose own calibration is traceable to national standards. This should be assessed at two velocities in the range 2-20 m s⁻¹ e.g. 10 and 20 m s⁻¹.

Linearity

- A1.5 The linearity of the isokinetic response of the sampler to different flue gas velocities shall be tested over the full certification range of the instrument, using at least five velocity values approximately equally spaced across the range. The maximum difference between any measured point and the regression line fit to all the points shall be taken as the measure of linearity.

Drift (Short term)

- A1.6 The isokinetic response of the sampler to a set gas velocity shall be observed over a period of 24 hours, to check for the presence of drift. The output values shall be averaged over periods of four instrument rise times, and these averaged values shall be compared to the value set at the beginning of the test. The recorded drift of the equipment shall be taken to be the difference between the value measured at the end of the test compared with the value at the beginning of the test.

Minimum operating (flue gas) velocity

A1.7 The minimum operating flue gas velocity, below which the equipment fails to measure and respond isokinetically, shall be determined by increasing the velocity of the sample, using a wind tunnel, from zero until the equipment responds with a performance within the linearity criteria set down in Table 6.1. This minimum value should then be verified by reducing the velocity of the sample from a higher velocity to the minimum value to ensure the equipment continues to respond correctly. This value will be reported.

Repeatability

A1.8 The repeatability of the sampler is determined from the measured statistical variation of the isokinetic sampling rate response of the equipment when a set velocity is generated using a wind tunnel. The repeatability is defined as:

$$C_R = t_f(0.95) \cdot X_R$$

where:

C_R is the repeatability expressed in velocity units;
 X_R is the standard deviation of the measurements;
 $t_f(0.95)$ is the statistical Student t-factor for a 95% confidence level with f degrees of freedom

A1.9 Measurements shall be averaged over at least four times the response time of the equipment and the standard deviation calculated.

A1.10 The repeatability value determined by this test, expressed as a percentage of the maximum of the certification range, should be less than the value given in the performance criteria Table 6.1.

Suitability of construction material

A1.11 A visual inspection shall be made of the equipment to ensure that the materials of construction are adequate for prolonged exposure to the flue gas environment expected. If necessary the test-house may request details of construction materials from the manufacturer.

Monitoring of the sampling process

A1.12 Any functions offered by the system to monitor the sampling process, for example, software driven messages or data readouts, will be recorded in the test report.

A2 Field tests

Accuracy

A2.1 Accuracy of the volume sampled under field conditions shall be assessed using a suitable Standard Reference Method. The accuracy of the automatic isokinetic sampler is expressed in terms of the volume sampled. The system used, as the reference method should meet the criteria set within standards such as ISO 10780:1994. Measurements with the automatic isokinetic sampler and a suitably located SRM should be undertaken during month one and month three of the field trial.

Instrument availability under field conditions

A2.2 The overall availability of the sampler (as defined in BS EN 15267-3) is recorded during the three-month programme of site tests. This test applies to the continuous automatic isokinetic samplers only. The sampler availability is defined as the fraction of the total time for which the system operates within the required performance criteria.