This publication was withdrawn on 28 March 2025.

This guidance has been withdrawn because it has been superseded.

Please see MCERTS for automatic water sampling equipment.

Performance Standards and Test Procedures for Continuous Water Monitoring Equipment

Part 1 - Performance standards and test procedures for Automatic Water Sampling Equipment

Environment Agency
Version 4

April 2017

THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Foreword

The Environment Agency established its Monitoring Certification Scheme (MCERTS) to deliver quality environmental measurements. The scheme is based on international standards and provides for the type-testing and subsequent product certification of instruments, the competency certification of personnel and the accreditation of laboratories.

This document contains the performance standards and test procedures for automatic water sampling equipment (samplers) used, for example, in monitoring of treated discharges from waste water treatment works, industrial processes, untreated wastewaters and receiving waters.

MCERTS for samplers:

- makes available a certification scheme that is formally recognised within the UK and is acceptable internationally

- gives confidence to regulatory authorities that 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 UK regulatory authorities

- supports the supply of accurate and reliable data to the public

- provides equipment 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

The MCERTS performance standards for automatic water sampling equipment 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.

MCERTS for samplers provides a formal scheme for the product certification of continuous automatic sampling equipment conforming to this standard. We have appointed Sira Certification Service (the Certification Body) to operate MCERTS on our behalf.

Product certification comprises two phases. These are:

- **Laboratory testing** – used to determine performance characteristics, where such testing requires a highly controlled environment.

- **Surveillance - initial and continuing** – which comprises 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 standard.

Test organisations shall demonstrate to the satisfaction of the Certification Body that they comply with the relevant requirements of ISO/IEC 17025[2] for the testing of samplers under MCERTS.

The results of other tests may be acceptable to the Certification Body, if they are shown to be equivalent to MCERTS and carried out independently. Manufacturers' own test data may also be considered, if it also meets the MCERTS standards for testing and data quality.

Certification for defined applications and/or conditions

The role of the Certification Body is to assess and certify compliance with this MCERTS standard for defined applications and/or conditions. In performing this role, the Certification Body considers the relevance of the procedures specified in the MCERTS standard for the product to be certified. In some cases the technology or intended application of the product may make one or more of the MCERTS tests inappropriate. The Certification Body is required by the MCERTS scheme to exercise its technical judgement when considering such matters.

- Any certification decision based on technical judgement of the standard shall be taken by an appropriately independent, competent person or group of persons, referred to as the "Certification Committee".

- Any certificate issued by the Certification Body shall identify any variations from the normative MCERTS standard.

Further information

If you have any questions regarding the certification process, or would like further information on how to make an application, please contact:

CSA Group Testing UK Ltd
Sira Certification Service
Unit 6
Hawarden Industrial Park
Hawarden
DEESIDE
CH5 3US

Tel: +44 (0) 1244 670900
email: mcerts@siraenvironmental.org

If you have any general questions about MCERTS or comments on this document please contact our National Customer Contact Centre at:

Email: enquiries@environment-agency.gov.uk

Tel: +44 (0) 3708 506 506

Further information is available from www.mcerts.net .

Record of amendments

Version number	Date	Amendment
1	February 2003	First published.
2	October 2006	Format updated to bring into line with CWM and PWM standards. Amendments to background (1.1.2 – 1.1.4). Previous performance test added (1.2.1). Scope of MCERTS scheme updated (2.1.2). General requirements restructured (3.1). Performance requirements updated with new clause to specify sampler must meet error requirements at each tested sampling head. Clause 5.2.2 added on data calculation methods. Number of prior sampling cycle required before testing reduced from 5000 to 2000 in 5.3.4. Reporting clause 5.4.1 added. Initial checks for laboratory tests added to include 6.1.1. – 6.1.3. Calculation and reporting text modified (6.2. Sampling heads above 7 meters may be tested (6.2). Certification process added as Annex A. Determination of performance characteristics added as Annex C.
2.1	November 2009	Title changed from “automatic waste water sampling equipment” to “automatic water sampling equipment”. Foreword updated. Annex C2 (sample line velocity worked example) amended.
3	May 2015	Amended to include tests and requirements described in BS EN 16479:2014, with subsequent changes to a number of sections. Foreword updated. Requirements updated. Tests updated: Sample flow test amended; New tests added: Power supply, Sampling principles
3.1	July 2015	Minor correction of wording in section 4.1.7 for clarification
4	March 2017	Minor change to Foreword Minor change to introduction (1.1.6 and 1.3.2). Added a requirement to state the rated power supply (3.1.2). Clarification of MCERTS requirement (4.1). Amended wording of ambient temperature requirements (4.1.7) to show as three separate ranges. Limit to variation of the sampling head during tests added at 6.2.3 Amended calculation in Sample volume test for CTVV principle (6.4.1.2) Removed requirement for manual monitoring (6.4.2.2, 6.4.2.3 & 6.4.2.4) Clarification of sample line velocity test (6.4.3). Amended the wording in the power supply test (6.4.4.1 & 6.4.4.2); the sampler timing error test (6.4.6) and ambient temperature test (6.4.7.2) in order to make them easier to understand. Minor changes to the wording in annex A.1, A.4 and B. New example calculations in Annex C (C.1 and C.2).

Status of this document

This document may be subject to review and amendment following publication. The latest version of this document is available on GOV.UK at:

www.mcerts.net

Contents

Performance standards and test procedures for automatic water sampling equipment

1. Introduction

1.1 Background

1.1.1 This MCERTS performance standard describes the performance standards, test procedures and general requirements for the testing of automatic water sampling equipment (samplers) for compliance with the MCERTS scheme.

1.1.2 It incorporates the requirements and test procedures described in BS EN 16479: 2014 Water Quality – Performance requirements and conformity test procedures for water monitoring equipment – Automated sampling devices (samplers) for water and waste water, with some amendments and clarifications based on our experience of using BS EN 16479:2014.

1.1.3 The certification process is explained in Annex A.

1.1.4 The Environment Agency requires operators of regulated processes to use MCERTS certified equipment.

1.1.5 It is the responsibility of the user to ensure that the selection, installation and operation of an automatic sampler are appropriate to the application.

1.1.6 The main performance characteristics against which a sampler will be assessed are:

- sample volume error
- maintenance of sample line velocity over the certified conditions including the specified lift height range and when subject to power supply variation
- sample integrity
- timing accuracy
- immunity to ambient temperature variation

1.1.7 These MCERTS performance standards and conformity tests apply to automatic water sampling equipment that:

- samples aqueous wastewater from non-pressurised (i.e. open to atmosphere) channels or vessels
- samples over extended periods to collect discrete or composite samples based on time or flow proportional sampling
- is intended to be permanently or temporarily sited

1.1.8 Automatic water samplers to be used for the collection of samples of wastewater treatment works final effluent or influent for the purpose of monitoring the performance of the treatment process, as required under the Urban Waste Water Treatment Regulations[3] (UWWTR), shall also be assessed against the specific variations on the performance requirements listed in Annex B.

1.1.9 Automatic water samplers to be used for industrial or other applications do not have to be assessed against the specific variations on the performance requirements listed in Annex B. However, the Certification Body shall be consulted on any application specific requirements for which appropriate conformity tests could be determined.

1.2 Repairs, maintenance and modifications to certified samplers

1.2.1 Any spares or replacement parts for certified samplers 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 sampler manufacturer.

1.2.2 Modifications to certified samplers are allowable, provided manufacturers can demonstrate that these design changes do not degrade the performance of the sampler below the MCERTS performance-standards.

1.2.3 Manufacturers shall keep detailed records and drawings of all design changes to samplers, and have provisions for design verification, inspection and testing to ensure that the samplers still meet the required performance standard.

1.2.4 The Certification Body will conduct audits of the design changes to samplers 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 sampler performance.

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

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

1.2.7 In the case of modifications to software, documentation shall 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.

1.3 Performance tests

1.3.1 Performance tests for certification of a sampler against the MCERTS requirements should normally be carried out in accordance with the procedures defined in this document.

1.3.2 The results of previous performance tests may be acceptable to the Certification Body, if equivalent to MCERTS, if carried out independently and if subsequent changes to the sampler are demonstrably not significant. Manufacturers' own test data may also be considered.

1.3.3 Variations to the performance tests described in this standard may be acceptable provided that they demonstrate, to the satisfaction of the Certification Body, the sampler's performance against the requirements. Any such variations shall be agreed with the Certification Body.

1.3.4 The decision of the MCERTS Certification Committee on matters of data is final.

2. Scope of the MCERTS scheme

2.1.1 MCERTS is designed to support the requirements of EU Directives and the standards cited within these Directives.

2.1.2 MCERTS for automatic water samplers covers:

- processes falling under the Environmental Permitting Regulations[4]
- processes falling under the Industrial Emissions Directive[5]
- consented discharges for processes regulated through provisions of the Water Resources Act,1991[6]
- sites falling under the Urban Wastewater Treatment Directive (UWWTD)[7]
- sites falling under other relevant directives, for example, the Water Framework Directive[8,9]
- other monitoring of the aquatic environment

3. General requirements

3.1 General requirements for all automatic samplers

The following requirements will be assessed by inspection or manufacturer's statement for all automatic samplers.

3.1.1 The manufacturer shall state any specific installation requirements.

3.1.2 A sampler shall:

a) Have a unique designation that unambiguously identifies it (e.g. model, serial number). If the certified sampler is based on a previous non-certified model, then the certified sampler shall have a distinct designation to distinguish it from the non-certified model.

b) Be designed (including its operating methodology) and constructed to ensure that the composition of the sample is, as far as is practicable, not altered by the sampling procedure.

Note: It can be impracticable to prevent the loss of volatile substances during sampling with vacuum and peristaltic samplers.

c) Have a rated maximum lift height at which all of the performance requirements of this standard are fulfilled. The rated maximum lift height shall be inscribed on the sampler or declared in the operating manual published by the manufacturer.

Conformity testing of the sampler shall be based on a range of lift heights up to and including the sampler's rated maximum lift height.

d) Have provision for the user to set the volume of a discrete sample.

e) Have rated minimum and maximum sample volumes of a discrete sample inscribed on the sampler or declared in the operating manual published by the manufacturer.

Unless otherwise stated conformity testing of the sampler shall be based on a sample volume of 250 ml or the rated maximum sample volume, if smaller.

f) Have the stated capacities, for any integrated sample storage, both by number(s) and volume(s) of individual bottles and of a composite container, inscribed on the sampler or declared in the operating manual published by the manufacturer.

g) Be capable of collecting a series of samples, on a timed, event and/or a flow proportional basis. Samples can be collected and stored in individual bottles or a single composite sample bottle.

h) Have possible sampling intervals inscribed on the sampler or declared in the operating manual published by the manufacturer.

i) Have provision for the user to set the sample interval as a minimum in the range 5 min to 1 h with increments of 1 min, for time proportional samplers.

j) Have provision for the sample interval (in the case of C.V.V.T. sampling) or the sample volume (in the case of C.T.V.V. sampling) to be set on the basis of a flow signal (e.g. pulse or analogue) from a flow meter. For pulse inputs, the relationship between pulse input and sample interval or volume should be adjustable as a minimum over the range 1 pulse to 999 pulses in increments of 1 pulse.

Note: The possible sampling options are illustrated in Annex E.

k) Have a control unit capable of recording sample collection failures.

l) A sampler designed to be powered by an internal or external battery shall have a rated maximum and minimum battery voltage at which all of the performance requirements of this standard are fulfilled. The rated minimum and maximum voltages shall be inscribed on the sampler or declared in the operating manual published by the manufacturer.

m) Have a control unit capable of recording a low battery alarm during sample collection.

n) Be designed to minimise the possibility of clogging of the sample line by suspended solids in the waste water. The nominal internal diameter of the sample line shall be not less than 9 mm.

These requirements on sample line diameter exclude pipe restriction caused by the normal operation of pinch valves and peristaltic pumps.

o) The average sample line velocity shall not be less than 0.5 m/s. The sampler shall be capable of achieving this average sample line velocity at all lift heights, up to and including its maximum rated lift height at all rated operating voltages.

p) Be capable of purging the contents of the sampling line between each sampling event.

q) Have stated ingress protection (IP) rating inscribed on the sampler or stated in the operating manual.

Requirements for ingress protection are detailed in EN 60529:1991[10]

3.1.3 The rated operating conditions for the process fluid temperature shall be at least +1°C to +25°C.

4. Performance requirements

4.1 Performance characteristics

This section describes minimum performance requirements necessary for MCERTS certification, in addition to the general requirements described in section 3.

Test conditions and procedures described in sections 5 and 6 should be used to determine the instrument performance (see 1.3).

4.1.1 Sample volume

The bias (mean error) of the sample volume and expanded uncertainty at the 95% confidence limits shall each not be greater than 5% of the set volume over the tested range for lift height.

4.1.2 Sample line velocity

The average velocity of the sample as it passes through the sample line during the sampling event shall not be less than 0.5 m/s, at each tested lift height and at the rated voltage for the power supply.

4.1.3 Power supply

The average velocity of the sample as it passes through the sample line during a sampling event shall not be less than 0.5 m/s at the maximum rated lift height between the minimum and maximum rated voltages for the power supply.

Note: The requirement from BS EN 16479: 2014 has been amended to provide clarification of the pass / fail criteria.

4.1.4 Sample timing error

The error of the sampler interval timing mechanism shall be no greater than ±10 seconds per 24 hours.

4.1.5 Event triggered timing error

The sampler shall commence sample extraction within 10 seconds of a trigger signal being received from an external input.

Note: The requirement from BS EN 16479: 2014 has been amended to provide clarification of the pass / fail criteria.

4.1.6 Sample Integrity

The construction and operating methodology of the sampler shall be such as to ensure that the chemical composition of the sample is not significantly altered by the sampling procedure.

Specifically, for samplers certified for use on a site regulated under the UWWTD, analyses for BOD (biochemical oxygen demand), COD (chemical oxygen demand), total nitrogen, and total phosphorus in samples taken by the sampler and in samples taken manually from a test fluid, shall show no significant statistical difference, based on an analysis of variance.

The design of a sample integrity test for other applications shall be based on EN ISO 5667-3[11], which describes the precautions to be taken to preserve and transport water samples. The same pass criteria should be applied when using a test fluid for an application other than the UWWTD, and for which relevant determinands have been identified.

4.1.7 Effect of ambient temperature

a) Samplers NOT incorporating sample temperature control

Samplers which do not incorporate a means for maintaining the temperature of the sample within pre-set limits shall meet the sample volume error requirements in 4.1.1 when operated within one of the following sets of rated operating conditions with regards to ambient temperature:

i) +5°C to +40°C
i-a) 0°C to +40°C
ii) -10°C to +40°C.

If the sampler or sampler variant is only suitable for indoor use, it shall be clearly identified on the sampler.

Samplers that are not certified at a minimum ambient temperature of 0°C or lower shall have a clear label on the sampler, which stipulates the specific ambient temperature range.

Note 1: Temperature range i) should be used for samplers without integral frost protection, which are designed for use only indoors where the building provides protection from frost.

Note 2: Some samplers with limited insulation designed for outdoor use may not operate at range ii) [-10°C to + 40°C]. For those samplers, range i-a) should be used with a minimum temperature of 0°C.

Note 3: Temperature range ii) should be used for samplers designed for use outdoors, with integral frost protection.

Note 4: Range i) and ii) are also specified in EN-16479. Range i-a) is an additional range for MCERTS certification.

b) Samplers incorporating sample temperature control

Samplers that incorporate a means for maintaining the temperature of the sample within pre-set limits shall meet the sample volume error requirements in 4.1.1 when operated within an ambient temperature range of:

-10°C to +40°C.

The mean temperature of the sample shall be maintained within the range 0°C to +5°C during the sampling period, when the sampler is operated within the rated operating conditions for ambient temperature and process fluid temperature.

The design of the sample temperature control shall ensure that ice does not form in the sample.

In the case of mains powered samplers, after completion of the sampling period, the sample temperature shall remain within the range 0°C to +5°C for a minimum period of 24 hours with no formation of ice.

In the case of portable samplers, which are not powered directly from a mains electricity supply, the minimum period of time, from the end of the sampling period, over which the temperature of the sample will remain within the range 0°C to +5°C, with no formation of ice, shall be 12 hours.

5. Provisions for test organisations

5.1 General requirements for test organisations

5.1.1 Test organisations shall demonstrate to the satisfaction of the Certification Body that they comply with the relevant requirements of ISO/IEC 17025 for testing of samplers under MCERTS.

6. Laboratory test procedures

6.1 General requirements for testing

6.1.1 The sampler shall be installed in accordance with any instructions provided by the manufacturer.

6.1.2 Each performance requirement for the sampler shall be considered on its own when performing the conformity tests.

6.1.3 Conformity testing of the sampler shall be carried out in accordance with the requirements of ISO/IEC 17025 or other equivalent standards accepted at international level.

6.1.4 Sampler conformance should be determined by processing the data from the tests in accordance with the calculation methods summarised in Annex C.

6.1.5 Results from the conformity testing should be reported using the proposed format for the report given in Annex D.

6.2 Test Conditions

6.2.1 The sample line shall be arranged so that no part of the sample is retained within the sample line.

6.2.2 During tests that require the sampler to collect a sample of fluid, the vessel containing the fluid to be sampled shall be open to the atmosphere.

6.2.3 Where a test requires repeated samples to be taken, the sampling head shall not change by more than 5% during the test.

6.2.4 In the case of a battery powered sampler, the battery shall be fully charged at the start of each conformity test, unless stated otherwise in the test conditions.

6.2.5 Prior to carrying out any series of consecutive tests, the sampler shall be operated, for a total operating period of 2000 sampling cycles, under the following conditions:

- the rated maximum lift height (maximum sampling head stated by the manufacturer)
- sampling interval 5 minutes
- sample volume 250 ml, or the stated maximum volume, if less than 250 ml
- samples shall be discarded or run to waste

6.2.6 The equipment should be maintained, cleaned or recalibrated in line with manufacturer's instructions prior to any test, but adjustments shall not be carried out during the course of the test.

6.2.7 Table 1 gives the reference conditions for possible influence quantities. Tests shall be carried out with all influence quantities at their reference values, including tolerances, unless where specifically varied in any one test.

Table 1 Reference conditions

Influence quantity	Reference value	Tolerance
Ambient temperature	20°C	±2.5°C
Ambient humidity at 20°C	<60%	
Sample temperature	20°C	±2.5°C
Supply voltage (a.c.)	230V[a] or 110V	±6%
Supply voltage (d.c.)	To be stated by the manufacturer	To be stated by the manufacturer
a) see EN 60038:2011[12]		

6.3 Initial checks

6.3.1 The test house shall ensure that the sampler is set up, calibrated and adjusted in accordance with the manufacturer's instructions.

Note: The manufacturer may set up and demonstrate the sampler before the testing begins.

6.3.2 The sampler (or statements in the manufacturer's operating manual) shall be inspected to verify it conforms to the general requirements listed in Section 3, as appropriate to the sampler under test. The means by which each requirement is fulfilled shall be reported.

6.3.3 The test house shall verify and report that the displayed operational status is correct.

6.4 Performance Tests

6.4.1 Sample volume

The sample volume errors shall be determined according to the procedures stated below. All available options shall be tested.

Note: See Annex E for an illustration of C.T.C.V.; C.T.V.V. and C.V.V.T.

6.4.1.1 C.T.C.V. Time proportional sampling principle

Determine the sample volume errors in accordance with the following procedure:

1. Set the sampler to operate on time proportional sampling.

2. Programme the sampler to collect 24 samples with a fixed 10 minute sampling interval and a sample volume of 250 ml (or the maximum sample volume if less than 250 ml).

3. Operate the programme at a sampling head of 1 metre.

4. Measure and record the volume of each sample.

5. Repeat the sampling programme at the rated maximum lift height and at half the rated maximum lift height. In each case, measure and record the volume of each sample.

6. Calculate and report the following values (see Annex C):

   - the mean sample volume at each test height

   - the bias (mean error) at each test height as a percentage of the set volume

   - the expanded uncertainty (precision) at each test height as a percentage of the mean volume

6.4.1.2 C.T.V.V. Flow proportional sampling principle

Determine the sample volume errors in accordance with the following procedure:

For samplers capable of operating with different input signals (analogue, pulse, digital) each input should be tested separately.

1. Programme the sampler for the collection of C.T.V.V. flow proportional samples at a rate of 4 samples per hour and a sample volume of 25 ml/m^3. If possible, programme the input such that 100% of its range equals 100 m^3/h.

2. Operate the sampler at a sampling head of 1 metre.

3. Apply a simulated flow signal representing 25% of the maximum input signal until 6 individual samples have been collected.

4. Sequentially increase the flow signal to represent flow rates of 50%, 75% and 100%, and in each case collect 6 individual samples.

5. Determine the volume of each sample and the expected simulated flow volume increment between each sample event.

6. Repeat the procedure from step 2 for lift heights at the rated maximum lift height and at half the rated maximum lift height. In each case, measure and record the volume of each sample.

7. Calculate and report the following values (see Annex C):

- the mean sample volume at each test height and each flow rate
- the bias (mean error) at each test height as a percentage of the expected volume
- the expanded uncertainty (precision) at each test height as a percentage of the volume

6.4.1.3 C.V.V.T. Flow proportional sampling principle

The sample volume error is tested in 6.4.1.1. The accuracy of the sample triggering system is tested in 6.4.2. Therefore a separate test is not required.

6.4.2 Testing of sampling principles

6.4.2.1 General

For samplers capable of operation under more than one sampling principle, that is C.T.C.V. time proportional, C.V.V.T. flow proportional impulse, C.V.V.T. flow proportional analogue, and event triggered, all available sampling principle options shall be tested.

6.4.2.2 C.T.C.V.

This test may be combined with 6.4.1.1 (sample volume)

Samplers operating on the C.T.C.V. time proportional sampling principle shall be tested as follows:

1. Programme the sampler for the collection of time related samples based on 10 min per one 250 ml sample.
2. Operate the sampler at a sampling head of 1 m.
3. Run the sampler with this setup for 60 min.
4. Determine and report how many, and at what time, samples have been taken during this test period.

6.4.2.3 C.V.V.T. (impulse flow signal)

Samplers operating on the C.V.V.T. flow proportional sampling principle controlled by an impulse signal shall be tested as follows:

1. Connect the sampler to a suitable flow impulse generator.
2. Programme the sampler for the collection of flow related samples based on 10 impulses per one 250 ml sample.
3. Operate the sampler at a sampling head of 1 m.
4. Apply a simulated flow impulse at a fixed frequency of 1 impulse per minute.
5. Run the sampler with this setup for 60 min.

6. Determine and report how many, and at what time, samples have been taken during this test period.

6.4.2.4 C.V.V.T. (analogue flow signal)

Samplers operating on the C.V.V.T flow proportional sampling principle controlled by an analogue signal shall be tested as follows:

1. Connect the sampler to a suitable analogue flow signal generator.

2. Programme the sampler for the collection of flow related samples based on the analogue input with 1 sample to be taken every 5 min with the maximum input flow rate signal.

3. Operate the sampler at a sampling head of 1 m.

4. Apply a simulated flow rate signal representing 50% of the maximum flow.

5. Run the sampler with this setup for 60 min.

6. Determine and report how many, and at what time, samples have been taken during this test period.

6.4.2.5 Event triggered sampling

Samplers operating on the event triggered sampling principle shall be tested as follows:

1. Connect the sampler to a suitable event trigger generator.

2. Programme the sampler for the collection of event triggered samples based on 1 trigger per one 250 ml sample.

3. Operate the sampler at a sampling head of 1 m.

4. Apply a simulated event trigger at a fixed frequency of 1 trigger per 10 min.

5. Run the sampler with this setup for 60 min.

6. Determine and report how many, and at what time, samples have been taken during this test period.

6.4.3 Sample line velocity

The sampler shall be operated at lift heights between 1 m and the maximum rated lift height in increments of 1 m.

Prior to undertaking the sample line velocity test, battery powered samplers shall be conditioned as follows to demonstrate the battery capacity and to ensure that the sampler can operate for more than 24 h. To condition the sampler, fully charge the battery, then using the sampler, collect 24 samples under the following conditions:

— sample interval 1 h

— sample volume 250 ml (or the maximum sample volume if less than 250 ml)

— the rated maximum lift height

— carry out steps 1 to 6 of the sample line velocity test within a period of 2 h after the completion of the sampling operation without recharging the battery

Determine the mean sample line velocity at each lift height by the following procedure:

1. Set up the sampler with a vertical sampling line of total length equal to the sampler's maximum rated lift height plus 1 m. Calibrate the sampling line with marks at 1 m divisions from a reference point at the surface of the liquid being sampled to the inlet port of the sampler.

2. Operate the sampler and determine the time taken from the instant that the leading edge of the sample fluid passes the reference point to when the leading edge passes the 1 m mark.

3. Repeat step 2 two more times to provide three determinations at the 1 m lift height.

4. Increase the lift height by 1 m intervals up to the sampler's maximum rated lift height.

5 At each lift height operate the sampler and determine the time taken from the instant that the leading edge of the sample fluid passes the reference point at the surface of the liquid to when the leading edge passes the relevant height mark. Carry out the measurement 3 times.

6. Calculate the mean sample line velocity in metres per second (m/s) at each lift height by dividing the height in metres by the time taken in seconds.

7. Report the individual test results, the mean sample velocity and the associated lift height.

6.4.4 Power supply test

6.4.4.1 Mains supply samplers

For mains supply samplers, the following power supply test shall be carried out:

1. Operate the sampler at the rated maximum lift height.

2. Set the supply voltage to the maximum rated voltage for the sampler.

3. Carry out the sample line velocity test detailed in 6.4.3 at the maximum rated lift height.

4. Reduce the supply voltage to the middle of the rated voltage range and repeat steps 1 to 3.

5. Reduce the supply voltage to the minimum rated voltage, or until a low power alarm is displayed, whichever is greater and repeat steps 1 to 3

6. If a low power alarm has been activated, reduce the supply voltage to the minimum rated voltage and repeat steps 1 to 3.

7. Report:

   a) the sample line velocity at each voltage

   b) the voltage at which a low power alarm is displayed or the sampler ceases to operate

6.4.4.2 DC and battery powered samplers

For both DC and battery powered samplers the following power supply test shall be carried out:

1. Remove the batteries from the sampler and substitute a variable DC power supply.

2. Set the supply voltage to the rated voltage for the sampler.

3. Carry out the sample line velocity test detailed in 6.4.3 at the maximum rated lift height only.

4. Increase the supply voltage by 10% and repeat the sample line velocity test detailed in 6.4.3 at the maximum rated lift height only.

5. Return the voltage to the rated voltage for the sampler.

6. Reduce the voltage by 0.5 V and repeat the sample line velocity test detailed in 6.4.3 at the maximum rated lift height only.

7. Repeat step 7 until a low power alarm is displayed or the sampler ceases to operate.

8. Report:

   a) the voltage at which the low power alarm is displayed or the sampler ceases to operate

   b) the mean sample velocity at each voltage and the associated supply voltage

   c) identify the maximum change in sample velocity caused by changes to the supply voltage

6.4.5 Sample integrity

The test for sample integrity shall be carried out at the rated maximum lift height and at half the rated maximum lift height. The sampler shall be set up in manual grab sample mode and set up to sample a test fluid which is representative of waste water from an urban waste water treatment plant regulated under the UWWTD.

Note: Annex B provides information on concentration ranges for biochemical oxygen demand (BOD), chemical oxygen demand (COD), total nitrogen, and total phosphorus in waste waters.

During the test, the test fluid shall be maintained in a homogeneous state, this can be achieved by the use of a mechanical stirrer or a small submersible pump. The method of stirring shall avoid drawing air into the test fluid.

The test for sample integrity shall be carried out using the following procedure:

1. Obtain 50 litres of test fluid and a supply of de-mineralized water.

   If the sampler works with a conductivity sensor to monitor the presence of sample liquid a dilute solution of sodium chloride with a conductivity appropriate to the sampler may be used.

2. Install the sampler at a lift height of half the rated maximum.

3. Insert the sample line in a container of fresh de-mineralized water.

4. Operate the sampler and collect 1 litre of de-mineralized water as four discrete samples of 250 ml each. Discard each sample.

5. Relocate the sample line into the container of test fluid, operate the sampler and collect a composite 1 litre sample of test fluid by combining four discrete samples of 250 ml each.

6. Obtain 1 litre of test fluid manually from the container of test fluid in such a way as to ensure that this sample is representative, in terms of the determinands of interest, of the test fluid.

7. Label each sample with a unique code. Record and report the date, time, sampling height and sample codes.

8. Place the sample line into a container of fresh de-mineralized water and repeat steps 4 to 7, then proceed to step 9.

9. Relocate the sampler at the rated maximum lift height. The sampler can be calibrated to the new lift height before re-starting the sampling programme.

10. Repeat steps 3 to 8 inclusive.

11. Determine the concentration of BOD (biochemical oxygen demand), COD (chemical oxygen demand), total nitrogen, and total phosphorus in the 8 samples of test fluid (4 manual samples and 4 composite samples obtained using the sampler) using standard reference analytical methods.

12. Undertake an analysis of variance in accordance with Annex C. Report the analysis of variance calculation.

The sampler shall pass the test if there is no statistical difference between the set of 4 manual samples and the set of 4 samples obtained using the sampler, for any of the determinands agreed with the Certification Body for industrial applications or as listed in Annex B for UWWTR.

6.4.6 Sampler timing error

The sampler shall be tested for sample timing error by the following procedure:

1. Programme the sampler to collect 24 samples with a sampling interval of 60 minutes and a sample volume of 250 ml (or the maximum sample volume if less than 250 ml).

2. Operate the sampler at any convenient sampling height.

3. Determine the elapsed time from the instant the sampler activates for the first sample to the instant the sampler activates for the twenty fourth sample.

4. Calculate the timing error as the elapsed time between the first and last sampling action minus 23 hours, such that if the timing function overruns the error is reported as positive.

5. Normalise the timing error to seconds per 24 hours by dividing by 23 and multiplying by 24.

6. Report the error as seconds per 24 hours.

6.4.7 Ambient temperature effects

6.4.7.1 Test settings

The sampler shall be tested for sensitivity to ambient air temperature by the following volumetric test and sample temperature control test procedures.

Install the sampler within a temperature controlled test chamber. The chamber shall be capable of maintaining the temperature of the air surrounding the sampler at the required value, with a tolerance of ±2°C. Allow sufficient time to ensure that the equipment under test has reached a stable operating temperature (at least 5 h) before the sampling programme is initiated. During each test, maintain the temperature of the fluid being sampled at a value of 20°C ± 2.5°C.

6.4.7.2 Volumetric test

Undertake the following test once at each of the rated lower and upper ambient temperature limits for the sampler as specified in clause 4.1.7:

1. Programme the sampler to collect 24 samples with a sampling interval of 60 minutes and a sample volume of 250 ml (or the maximum sample volume if less than 250 ml, in which case state the actual volume used).

Note: In the case of samplers with less than 24 bottles then the samples collected will be distributed equally between the available number of bottles.

2. Place the sampler in a temperature controlled environment, reduce the ambient temperature to the lower rated temperature limit and allow the conditions to stabilise.

3. Operate the sampler at its rated lower operating ambient temperature for 24 hours to collect samples as programmed in step 1. Measure the sample

volume in each of the sample bottles and examine the sample fault log for indication of malfunction.

4. Increase the ambient temperature to the upper rated temperature limit and allow the conditions to stabilise.

3. Operate the sampler at its rated upper operating ambient temperature for 24 hours to collect samples as programmed in step 1. Measure the volume of sample in each of the sample bottles and examine the sample fault log for indication of malfunction.

4. Calculate and report (see Annex C):

   - the mean sample volume at each temperature
   - the bias (mean error) at each temperature as a percentage of the mean volume
   - the expanded uncertainty (precision) as a percentage of the mean volume at each temperature

5. Report the details of any malfunction identified by the sample fault log.

6.4.7.3 Sample temperature control test

This test applies only to samplers with temperature control. Test the sampler at ambient temperatures of -10°C, +20°C and +40°C.

Note: there is an error in EN 16479. It states that the sampler is tested at an ambient temperature of +10°C. This should be -10°C, as shown in section 5.7.2.

The sample temperature control test is carried out using the following procedure:

1. Programme the sampler to collect 24 samples with a sampling interval of 60 minutes and a sample volume of 250ml (or the maximum sample volume if less than 250ml. State the volume used). Collect the samples as a composite into a single container. Install calibrated thermocouples into the composite sample container, the source fluid container and the test chamber and away from interfering airflow. High performance thermocouples with repeatability (±0.1°C) and tolerance (±0.5°C) over the range from -40°C to +125°C should be used. Record the output from each thermocouple independently taking a reading at least every 5 seconds. Report these readings as a series of averages calculated at 5 minute intervals throughout the test period.

Note: T type thermocouples are recommended due to their good repeatability (±0.1°C) and tolerance (±0.5°C) over the range –40°C to +125°C. Other systems of equal or better performance may be used.

2. Operate the sampler at each ambient test temperature for 24 hours.

3 At the end of the sampling period, leave the sampler in the test chamber for a further 24 hours at the ambient test temperature.

4. Examine the sample collected and observe and report whether there is any formation of ice within the sample.

5. For each ambient test temperature calculate and report (See Annex C).

(i) The maximum, minimum and mean sample temperature during the 24 hour sampling period.

(ii) The maximum, minimum and mean sample temperature during the 24 hour post sampling period. If the sample temperature exceeds the range 0°C to 5°C during the post sampling period, identify the time at which this condition occurred and the time period over which the sample temperature remained outside the specified temperature values.

(iii) The maximum, minimum and mean temperature within the test chamber during the 48 hour test period.

(iv) The maximum, minimum and mean ambient temperature of the fluid being sampled during the 24 hour sampling period.

6. Report, in graphical form, the recorded temperature within the sample from the start of the test to the completion of the 24 hour post-sampling period.

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Glossary

automated sampling device for water and waste water
automatic water sampling equipment (sampler)
automated sampler
equipment for collecting and storing samples of water or waste water for subsequent analysis

bias
estimate of a systematic measurement error

Note: The systematic measurement error is a component of measurement error that in replicate measurements remains constant or varies in a predictable manner.

[SOURCE: ISO/IEC Guide 99:2007, 2.18, modified — Note to entry has been added.][13]

composite sample
two or more samples or sub-samples, mixed together in appropriate known proportions (either discretely or continuously), from which the average result of a desired requirement may be obtained

Note: The proportions are usually based on time or flow measurements.

[SOURCE: ISO 6107-2:2006/AMD, 1:2012, 29][14]

constant volume variable time sampling
C.V.V.T.
flow proportional sampling based on collecting equal volumes of sample at frequencies proportional to flow

constant time variable volume sampling
C.T.V.V.
flow proportional sampling based on collecting samples at fixed time intervals but where the volume of sample is varied in proportion to the flow

constant time constant volume sampling
C.T.C.V.
equal volumes of sample or sub-sample collected at equal increments of time

determinand
property/substance that is required to be measured and to be reflected by/present in a calibration solution.

[SOURCE: EN ISO 15839:2006, 3.13][15]

discrete sample
single sample taken from a body of water.

[SOURCE: ISO 6107-2:2006, 40, modified – “process, whereby” deleted]

influence quantity
any quantity, generally external to the sampler, which may affect the performance of the sampler.

lift height
vertical distance between the surface of the fluid being sampled and the highest point to which the sample is lifted

Note 1: Sometimes called “sampling head” or “suction height”.

Note 2: The maximum lift height for samplers using vacuum pumps (e.g. pneumatic samplers and peristaltic samplers) is set to an atmospheric pressure of 1 000 mbar. At low atmospheric pressure the maximum lift height will be consequentially lower.

lower range limit
the minimum value of the range, as stated by the manufacturer

measurement error
error of measurement
error
measured quantity value minus a reference quantity value

Note 1: The concept of “measurement error” can be used both:

a) when there is a single reference quantity value to refer to, which occurs if a calibration is made by means of a measurement standard with a measured quantity value having a negligible measurement uncertainty or if a conventional quantity value is given, in which case the measurement error is known, and

b) if a measurand is supposed to be represented by a unique true quantity value or a set of true quantity values of negligible range, in which case the measurement error is not known.

Note 2: Measurement error is not be confused with production error or mistake.

[SOURCE: ISO/IEC Guide 99:2007, 2.16]

rated operating conditions
minimum to maximum values of any environmental, fluid or electrical parameter within which the sampler is designed to operate without adjustment and with errors within performance limits

reference conditions
where all influence quantities are within their individual reference values, including tolerances

reference value
fixed value of an influence quantity within the rated operating conditions which defines the reference condition for that quantity

precision
closeness of agreement between indications or measured quantity values obtained by replicate measurements on the same or similar objects under specified conditions

Note 1: Measurement precision is usually expressed numerically by measures of imprecision, such as standard deviation, variance, or coefficient of variation under specified conditions of measurement.

Note 2: The “specified conditions” can be, for example, repeatability conditions of measurement, intermediate precision conditions of measurement, or reproducibility conditions of measurement (see ISO 5725-3:1994)[16].

Note 3: Measurement precision is used to define measurement repeatability, intermediate measurement precision, and measurement reproducibility.

Note 4: Sometimes “measurement precision” is erroneously used to mean measurement accuracy.

[SOURCE: ISO/IEC Guide 99:2007, 2.15]

sampler
see automatic water sampling equipment

sampling interval
time between successive sampling events

sampling head
see lift height

sampling line
conduit from intake point to inlet of dosing system

[SOURCE: ISO 6107-2:2006/AMD, 1:2012, 115, modified – "sampling probe" was replaced by "intake port" and delivery point was replaced by "inlet of dosing system"]

time proportional sampling: See constant time constant volume sampling

Annex A – Certification process

Manufacturers seeking certification should contact the Certification Body, who will advise on any specific requirements for the automatic sampler under consideration.

A.1 Certification process

Product certification comprises two phases. These are:

- **Laboratory testing** – used to determine performance characteristics, where such testing requires a highly controlled environment.

- **Surveillance - initial and continuing** – which comprises 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.

Only a complete sampler shall be certified. Where a sampler can be supplied with a number of options, for example mains or battery powered, or where different enclosure options are available, one complete sampler shall undergo the full conformity tests.

In selecting the options to be tested, consideration should be given to the options likely to be used in the identified applications. For additional sampler configurations, it may be possible to extend certification by carrying out a subset of the full test programme.

Certification Body and Certification Committee

- The role of the Certification Body is to assess and certify compliance with the MCERTS standard for defined applications and conditions.

- In performing this role, the MCERTS scheme requires the Certification Body to consider the relevance of the procedures defined in the MCERTS standard to the specific product to be certified. The technology or defined application of a specific product may make certain of the documented tests inappropriate. The Certification Body is required by the MCERTS scheme to exercise its technical judgement when considering these matters.

- Any certification decision based on technical judgement of the standard shall be taken by an appropriately independent, competent person or group of persons, as required by ISO/IEC 17065, who in this MCERTS standard are referred to as the “Certification Committee”.

- When the Certification Body exercises its technical judgement the rationale supporting any such decision shall be appropriately documented.

- Any certificate issued by the Certification Body shall identify any variations from the normative MCERTS standard.

On request the Certification Body shall provide the MCERTS scheme owner with the rationale for any decision based on technical judgement, within the relevant confidentiality constraints.

Certification range

A automatic sampler will be certified over the range for which it is tested. The manufacturer shall state the maximum sampling head of the automatic sampler for certification.

A.2 Testing

Manufacturers may commission testing from any organisation, provided that the requirements for testing organisations can be met (see section 5). Manufacturers' own test data may also be considered <u>but should be assessed to demonstrate that it conforms to the requirements for testing organisations</u>.

A.3 Auditing and surveillance

An audit of the manufacturing process shall be conducted by the Certification Body to confirm that the manufacturer has provisions to ensure manufacturing reproducibility and to control any design changes that may affect product performance.
Subsequent surveillance audits are normally conducted annually until sufficient evidence of a well-proven, robust system has been collected. Once this has been established the Certification Body may extend the interval between audits or require submission of specific audit data for review off site.

A.4 Certificate validity

MCERTS certificates are valid for five years. After this time, the certification is reviewed and any necessary retesting will be identified to maintain the certification. Modifications to the sampler shall be considered as part of this process (see A.5).

Assessment for re-certification shall be carried out against the MCERTS standards current at the time of re-certification.

A.5 Modifications to certified automatic sampler

Modifications to certified 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 standards.

Manufacturers must keep detailed records and drawings of all design changes to samplers, and have provisions for design verification, inspection and testing to ensure that the samplers still meet the required performance standards.

The Certification Body will conduct audits of the design changes to 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.

Design modifications or extensions to the range of application of a sampler may require renewed 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 the performance of the sampler, then it would not be necessary to retest a sampler completely. In such cases, only a supplementary test would be required to the applicable MCERTS performance standards.

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.

All samplers submitted for testing shall be complete. These specifications do not apply to the individual components of a sampler and a certificate shall be issued for a complete specified sampler with all its components listed.

Annex B – Example procedure for demonstrating sample integrity for samplers to be used for Urban Waste Water Treatment Directive (UWWTD) sampling

B.1 General

This annex defines the key performance requirements for automatic sampling equipment, which are intended to be used to collect samples of wastewater treatment works final effluent or influent for the purpose of monitoring the performance of the treatment process as required under the Urban Waste Water Treatment Regulations (UWWTR). These specific requirements are referenced to the relevant clause in the specification.

The objective of setting sample integrity requirements is to ensure that the chemical composition of samples is not altered by the sampler's sampling system. This annex describes a procedure for determining conformance with the sample integrity requirements specified in 4.1.6 in accordance with the conformity test specified in 6.4.5.

B.2 Test fluid

The chemical composition of the sample shall not be altered by the sampling procedure.

Carry out the sample integrity test using a single test fluid, where the values for all the determinands in Table B1 are within the specified ranges, or with a number of test fluids each of which has one or more of the determinands within the specified ranges in Table B1. In the latter case, the test shall be repeated until the integrity of all 4 determinands listed B5 have been tested. Suspended solids test is optional (see Note 4).

Table B.1 — Determinand value ranges

Determinand	Lower limit mg/l	Upper limit mg/l
Suspended solids	17.5	52.5
COD	62.0	187
BOD	12.5	37.5
Total nitrogen	7.5	22.5
Total phosphorus	1.0	3.0

Note 1: Total nitrogen "means sum of total Kjeldahl nitrogen (organic and ammoniacal nitrogen), nitrate – nitrogen and nitrite – nitrogen. See note to Table 2 in Commission Directive 98/15/EC of 27 February 1998.

Note 2: The UWWTD does not define total phosphorus but specifies the "reference method as molecular absorption spectrophotometry". See Table 2 in Commission Directive 98/15/EC of 27 February 1998.

Note 3: The range for BOD, COD, total nitrogen and total phosphorus is the permitted concentration value ± 50 % of that value given in Tables 1 and 2 of the Urban Waste Water Treatment Directive (91/271/EEC). Where Table 2 includes two ranges, the higher range has been used.

Note 4: Suspended solids are included in the matrix as it is an optional requirement in the Urban Waste Water Treatment Directive (91/271/EEC). The lower range for suspended solids from Table 1 of the Urban Waste Water Treatment Directive (91/271/EEC) has been used. However, the integrity of solids collection is ensured through the requirements and tests for sample line velocity specified at 4.1.2 and 6.4.3.

B.3 Sample collection

Set up the sampler to take a minimum of 24 discrete samples without changing the sample containers.

B.4 Sample volume

Set up the sampler to:

a) take discrete samples of not less than 200 ml

b) collect not less than 2.5 l of sample in a composite or in individual bottles.

B.5 Sample integrity

In each of the eight samples (4 manual samples and 4 samples obtained using the sampler) collected determine the:

— biochemical oxygen demand (BOD)

— chemical oxygen demand (COD)

— total nitrogen

— total phosphorus

B.6 Determination of conformance

Calculate the statistical differences for each determinand for the sets of samples collected by the sampler and manually using the analysis of variance (see Annex C.3).

B.7 Ambient temperature (4.1.7)

The sampler shall incorporate a means for maintaining the temperature of the samples within pre-set limits of 0°C to +5°C.

Annex C – Determination of performance characteristics

C.1.1 Sample volume error (C.T.C.V.)

Calculate:

1) The mean sample volume at each tested lift height

2) The bias (in %), as the mean volume minus the set volume divided by the set volume, for each test height according to Formula C.1:

$$b = 100 \times (V_1 - V_2) / V_2 \qquad \text{(C.1)}$$

where
b is the bias in percent (%)
V_1 is the mean sample volume in millilitres (ml)
V_2 is the set sample volume in millilitres (ml)

3) The precision (in %) at the 95% confidence limit, as 1,96 times the sample standard deviation of the measured volumes divided by the mean volume according to Formula C.2:

$$S = (s/v_1) \times 100 \times 1.96 \qquad \text{(C.2)}$$

where
S is the precision in percent (%)
s standard deviation of the measured volume
V_1 is the mean sample volume in millilitres (ml)

In practice a factor of 2 rather than 1.96 is used. The worked example given in Tables C1.1 and C1.2 for an automated sampler tested at 1 m, 3.5 m and 7 m lift heights uses a factor of 2.

Note that the bias and precision sample volume error requirements are specified in section 4.

Table C.1.1 C.T.C.V Time proportional sampling principle (6.4.1.1)

Automatic sampler tested at 1, 3.5 and 7 metres lift height.

Sample Number	Volume collected ml				Sample Number	Volume collected ml		
	at 7m	at 3.5m	at 1m			at 7m	at 3.5m	at 1m
1	247	234	247		13	250	245	248
2	249	256	251		14	247	244	245
3	248	245	250		15	249	245	245
4	248	245	248		16	249	246	248
5	248	244	244		17	249	245	247
6	247	244	245		18	247	245	248
7	254	245	245		19	249	246	246
8	248	245	245		20	249	245	246
9	246	245	246		21	248	246	246
10	249	248	244		22	248	246	246
11	248	244	249		23	249	245	248
12	246	256	244		24	248	248	245

Table C.1.2 C.T.C.V Time proportional sampling principle (6.4.1.1)

	at 7m	at 3.5m	at 1m
Set volume ml	250	250	250
Mean volume ml	248.33	245.71	246.50
s (Std dev ml)	1.58	4.05	1.91
b (mean error %)	-0.67	-1.72	-1.40
S	1.26	3.24	1.53

C.1.2 Sample volume error (C.T.V.V.)

Calculate:

1) The mean sample volume at each flow rate setting for each tested lift height

2) For each sample calculate the error as % of the expected volume.
The collected volume minus the expected volume, multiplied by 100 and divided by the expected volume, according to Formula C.3:

$$e = 100 \times (V_3 - V_4) / V_4 \qquad \text{(C.3)}$$

where
e is the percentage error for each individual sample
V_3 is the collected sample volume in millilitres (ml)
V_4 is the expected sample volume in millilitres (ml)

3) Calculate the average of the percentage error values for each tested lift height to obtain the bias.

4) Calculate the standard deviation of the percentage error values for each tested lift height s_e.

5) Calculate the precision (in %) at the 95% confidence limit, as 1.96 times the sample standard deviation of the percentage error values according to Formula C.4:

$$S = s_e \times 1.96 \qquad \text{(C.4)}$$

where
S is the precision in percent (%)
s_e is the standard deviation of the percentage error

In practice a factor of 2 rather than 1.96 is used. The worked example given in Tables C1.3 and C1.5 for an automated sampler tested at 1 m, 3.5 m and 7 m lift heights uses a factor of 2.

Note that the bias and precision sample volume error requirements are specified in section 4.

Table C.1.3   C.T.V.V. Flow proportional sampling principle (6.4.1.2)

Automatic sampler tested at 1, 3.5 and 7 metres lift height.

Sample Number	Expected volume ml	Volume collected ml			error as % of set volume		
		at 7m	at 3.5m	at 1m	at 7m	at 3.5m	at 1m
1	156.25	149	150	150	-4.64	-4.00	-4.00
2	156.25	154	162	154	-1.44	3.68	-1.44
3	156.25	155	161	155	-0.80	3.04	-0.80
4	156.25	155	156	154	-0.80	-0.16	-1.44
5	156.25	156	156	158	-0.16	-0.16	1.12
6	156.25	159	159	161	1.76	1.76	3.04
7	312.5	312	311	315	-0.16	-0.48	0.80
8	312.5	320	320	316	2.40	2.40	1.12
9	312.5	316	312	315	1.12	-0.16	0.80
10	312.5	305	309	310	-2.40	-1.12	-0.80
11	312.5	300	301	308	-4.00	-3.68	-1.44
12	312.5	310	311	310	-0.80	-0.48	-0.80
13	468.75	465	469	469	-0.80	0.05	0.05
14	468.75	467	456	476	-0.37	-2.72	1.55
15	468.75	450	469	450	-4.00	0.05	-4.00
16	468.75	467	469	476	-0.37	0.05	1.55
17	468.75	465	476	469	-0.80	1.55	0.05
18	468.75	465	469	469	-0.80	0.05	0.05
19	625	618	622	620	-1.12	-0.48	-0.80
20	625	640	625	622	2.40	0.00	-0.48
21	625	620	622	622	-0.80	-0.48	-0.48
22	625	640	622	625	2.40	-0.48	0.00
23	625	620	625	620	-0.80	0.00	-0.80
24	625	622	625	618	-0.48	0.00	-1.12

Table C.1.4   C.T.V.V. Flow proportional sampling principle (6.4.1.2)

	at 7m	at 3.5m	at 1m
Mean volume 1 to 6	154.7	157.3	155.3
Mean volume 7 to 12	310.5	310.7	312.3
Mean volume 13 to 18	463.2	468.0	468.2
Mean volume 19 to 24	626.7	623.5	621.2

Table C.1.5   C.T.V.V. Flow proportional sampling principle (6.4.1.2)

Summary	at 7m	at 3.5m	at 1m
b (mean err %)	-0.64	-0.07	-0.34
s (Std dev %)	1.86	1.79	1.59
S	3.73	3.57	3.18

C.2 Sample Line Velocity

Automatic sampler tested up to 7 metres head.

Table C.2 Sample line velocity worked example

Lift Height m	Run	Measured time s	Velocity m/s	Average flow velocity m/s
2	a	3.49	0.57	0.57
	b	3.50	0.57	
	c	3.47	0.58	
3	a	5.31	0.56	0.57
	b	5.26	0.57	
	c	5.22	0.57	
4	a	7.10	0.56	0.56
	b	7.16	0.56	
	c	6.97	0.57	
5	a	8.88	0.56	0.57
	b	8.55	0.58	
	c	8.70	0.57	
6	a	14.00	0.43	0.42
	b	14.45	0.42	
	c	14.21	0.42	
7	a	20.25	0.35	0.34
	b	21.21	0.33	
	c	20.10	0.35	

Note that values for average flow velocity of <0.5 m/s will not meet the requirements specified in 3.1.2.

C.3 Sample integrity

Calculation of results based on the analysis of variance.

The analysis of variance technique is a statistical tool used to test the hypothesis that means from two or more samples are drawn from populations with the same mean, i.e. whether the variations seen in two sets of data are statistically significant. The formulae and numbers presented here are correct for this application, with 2 replications, 2 depths and 2 ‘treatments’ (sample/reference).

Notation

The observed (measured) values are denoted by A_{ijk}, where the suffixes are given in Table C3.1.

Table C.3.1 Notation

Suffix	Value = 1	Value = 2
i	Replicate 1	Replicate 2
j	lift height = 3.5m	lift height = 7m
k	Reference	Sample

The same suffix notation is also used for any derived values.

Averages are denoted by a bar, for example $\bar{A}_{.12}$, is the average over the replications at lift height 3.5m (j=1) for the sample (k=2).

In symbols $\bar{A}_{.12} = (A_{112} + A_{212}) / 2$

Similarly $\bar{A}_{..k}$ is the average over all replications and lift height. $\bar{A}_{...}$ is the overall average.

N is the total number of observations (= 8).

Calculations

The main effects are estimated as:

Effect of lift height $(E_d)_j = \bar{A}_{.j.} - \bar{A}_{...}$

Effect of treatment $(E_t)_k = \bar{A}_{.k} - \bar{A}_{...}$

For each effect, E, there are two values which are equal in magnitude but of opposite sign, that is:

$(E_d)_1+(E_d)_2 = 0$ and

$(E_t)_1+(E_t)_2 = 0$

The interactions (i.e. whether the effect of lift height is different between reference and sample, or the effect of reference/sample is different at different lift heights) are estimated as:

$$I_{.jk} = \bar{A}_{.jk} - \bar{A}_{.j.} - \bar{A}_{.k} + \bar{A}_{...}$$

Although there are 4 different interactions, there is only one independent value, and the other 3 are either equal to it or equal but of opposite sign.

Predicted values for each lift height and for sample/reference are calculated as the averages $\bar{A}_{.jk}$.

The Analysis Of Variance is then calculated as shown in Table C3.2. Many commercial spreadsheets incorporate this analysis.

Table C.3.2 Analysis of Variance Calculations

Source of Variation	Sum of Squares (S)	Degrees of Freedom (D)	Mean Square (M)	F	P-value	F_{crit} (note 1)
Lift Height (note 2)	$S_d = N \times (E_d)^2$	$D_d = 1$	$M_d = S_d/D_d$	M_d/M_r	note 3	7.71
Treatment (note 2)	$S_s = N \times (E_s)^2$	$D_s = 1$	$M_s = S_s/D_s$	M_s/M_r	note 3	7.71
Interaction	$S_I = N \times I^2$	$D_I = 1$	$M_I = S_I/D_I$	M_I/M_r	note 3	7.71
Residual	$S_r = \Sigma(A_{ijk} - \bar{A}_{.jk})^2$	$D_r = 4$	$M_r = S_r/D_r$			
Check (note 4)	$S_d+S_s+S_I+S_r$					
Total (note 4)	$\Sigma(A_{ijk} - \bar{A}_{...})^2$	7				

Notes:

1. This value is obtained from the F distribution (tables or in software), with degrees of freedom corresponding to (i) each row and (ii) the residual and with a level of significance of 5%.

2. Since $(E_d)_1 = -(E_d)_2$ and $(E_t)_1 = -(E_t)_2$ either value may be used in each case.

3. This value is provided by some spreadsheets. It is the probability of the observed differences, or more extreme differences, being obtained by chance, on a scale of 0 to 1. The lower it is, the more definite the evidence for a real difference.

4. When calculated, the values in these rows for the sum of squares column should be equal.

Interpretation of the results

When the values in Table C3 are calculated, if $F > F_{crit}$ on any line, then there is evidence of a real difference.

C.4 Sampler timing error

Method given in Section 6.4.6

Table C.4 Worked example

Test 6.4.6 Sample timing error	hh:mm:ss
Activation time for first sample	12:59:20
Activation time for 24th sample	11:59:15
Elapsed time for 24 samples	22:59:55
Timing error	-00:00:05
Normalised timing error	5.2 seconds

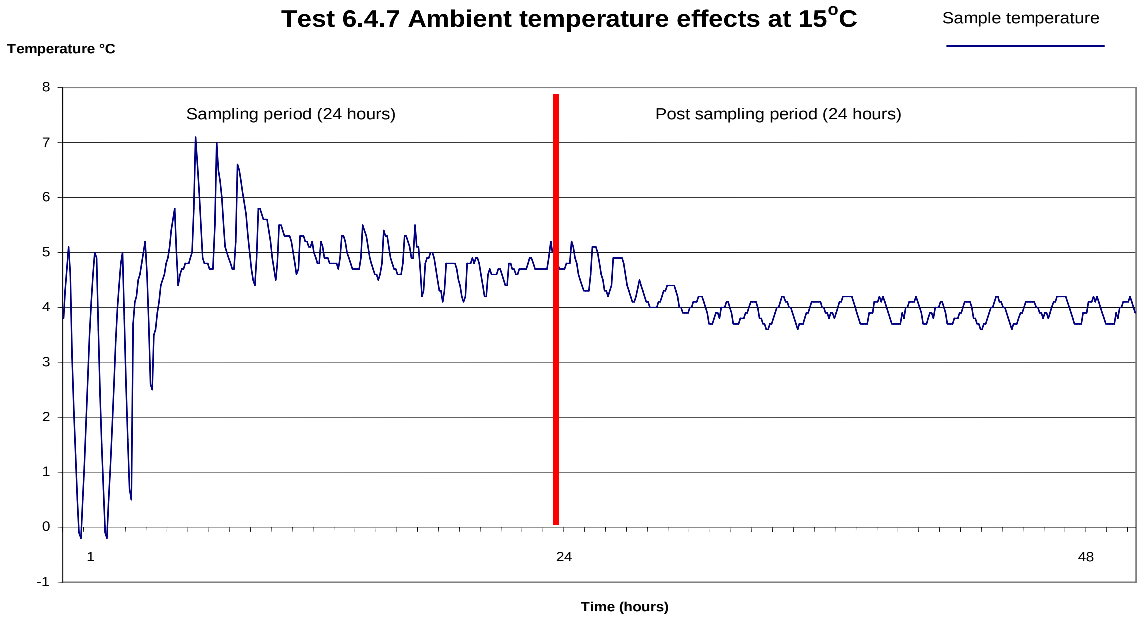
C.5 Ambient temperature effects

Method given in Section 6.4.7

Data to be presented as in the example below:

Table C.5 Example automatic sampler ambient temperature effects at 15°C.

Test 6.4.7 Ambient temperature effects	Max °C	Min °C	Mean °C
Environmental chamber temperature	17.8	15.3	15.8
Temperature of water being sampled	21	19.5	20.1
Temperature of sample (over 24h sampling)	7.1	2.5	4.9
Temperature of sample (over 24h post sampling)	4.5	3.6	4.0



Annex D – Format of the report

Test results should be reported in a tabular format as shown below. In addition, numerical results from performance tests should also be presented graphically, where appropriate.

Report format for performance evaluations of automated sampling devices (samplers) for water and waste water		
Name of Test Organisation		
Report type:		
Sampler tested:		
Manufacturer:		
Test period, from to		
Date of report:		
Report number:		
Scope of report:		
Contents		

1	**Synopsis with proposed scope of certification**	
1.1	Summary of test results	The report should include a brief summary of the performance of the sampler, stating the capabilities of the sampler with respect to the certification range(s).
1.2	Sampler details	The report should include the following information: • Specific sampler identity • Field of application • Any restrictions. Such limitations shall be recorded if testing shows that the sampler does not cover the full scope of possible application fields Attention must be drawn to any equipment peculiarities.
1.3	Previous test reports	In cases of supplementary or extended testing, reference must be made to all preceding test reports and include the name of the test organisation and the test report number and date of compilation.
2	**Task definition**	
2.1	Nature of the tests	First test or supplementary testing
2.2	Objectives	Specification of which performance specifications were tested Bibliography Scope of any supplementary tests
3	**Description of sampler tested**	

Report format for performance evaluations of automated sampling devices (samplers) for water and waste water		
3.1	Sampler scope and set-up	Description of all components covered in the scope of testing, Statement of technical specifications, if appropriate in tabular form
4	**Test programme**	
4.1	Laboratory test / laboratory inspection	Details should be provided on the test programme, in relation to the sampler under test In the case of supplementary or extended testing, the additional scope of testing must be detailed and substantiated Statement of all test steps involved
5	**Methods of reference measurements**	
5.1	Reference methods	State the sample matrix used. State the reference method used for sample analysis.
6	**Test results**	
6.1	Citation of MCERTS performance specifications	The Version of the MCERTS performance standard
6.2	Equipment	The report should outline the type of equipment used for the test
6.3	Method	There should be a brief description of the test
6.4	Maintenance	Details of any maintenance work and remedial actions necessary to ensure that the sampler met the performance standards should be reported.
7	**Test results**	
7.1	Summary table of test results	The test results should be summarised in a table and include the following information: • reference of the performance specification • the performance specification in abbreviated form • the test result • compliance with the specification (yes/no) • a reference to the relevant page of the test report • relevant comments and restrictions
7.2	Graphical presentation of results	
	Appendices	
A	Appendix A: Raw data from the tests	
B	Appendix B: Operating instructions	Instructions and manuals for the sampler should be appended to the report

Annex E – Illustration of sampling modes

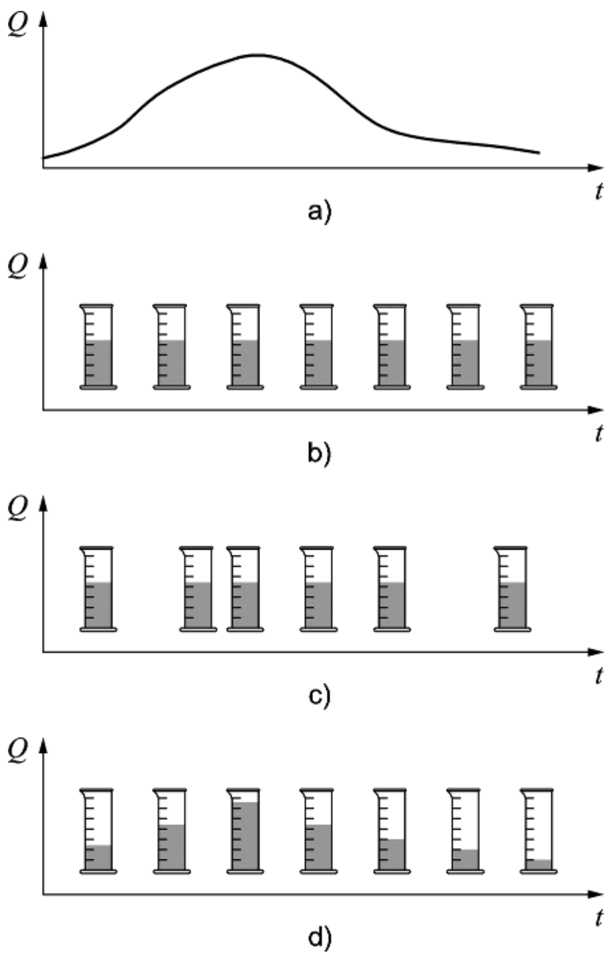


Figure 1 — Sampling modes

Key
Q = discharge
t = time
a) Flow rate curve
b) C.T.C.V. Time proportional sampling (Constant Time, Constant Volume)
c) C.V.V.T. Flow proportional sampling (Constant Volume, Variable Time)
d) C.T.V.V. Flow proportional sampling (Constant Time, Variable Volume)

diagram courtesy of Endress and Hauser

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