SLOVENSKI STANDARD
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Kakovost vode - Splošne zahteve in postopki preskušanja zmogljivosti opreme za monitoring vode - Merilniki

Water quality - General requirements and performance test procedures for water monitoring equipment - Measuring devices

Wasserbeschaffenheit - Allgemeine Anforderungen und Testverfahren zur Leistungsprüfung von Geräten zum Wassermonitoring - Messgeräte

Qualité de l'eau - Exigences générales et modes opératoires d'essai de performance pour les équipements de surveillance de l'eau - Dispositifs de mesure

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Water quality - General requirements and performance test procedures for water monitoring equipment - Measuring devices

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Contents

Page

European foreword

This document (EN 17075:2018) has been prepared by Technical Committee CEN/TC 230 “Water analysis”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

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Introduction

This document defines general requirements and test procedures for verifying the performance of measuring devices (MDs) used to monitor the quality of a wide range of waters including drinking waters, waste waters, and natural waters. It covers both portable measuring devices (PMDs) and fixed position measuring devices (FMDs). These devices include: sensors, single and multi-parameter instruments, discrete and batch instruments, probes and sondes. It excludes chemical test kits. For the purposes of this document the acronym MD(s) is used except where it is necessary to be specific about the particular type (e.g. PMDs, FMDs) or component of a MD (e.g. sensor).

This document is associated with EN 16479 [1] which covers automated sampling devices (samplers) for water and waste water.

The general requirements include several features that are necessary to meet users' applications and information that has to be included in associated documents.

The performance tests comprise testing carried out under laboratory and field conditions They are designed to determine, in a systematic and consistent way, the capability of MDs to make reliable measurements. The testing focuses on key performance characteristics. Statistical procedures are defined for evaluation of the test data.

The range of measurements over which the test procedures will be applied, the test range, is not specified. It is for the MD manufacturer and/or the user to decide on the test range. Similarly, it is for the MD manufacturer and/or the user to decide on the intended uses (applications) which will inform the design of the field trial.

Water monitoring equipment is widely used for compliance monitoring purposes under national and European regulations. This document supports the requirements of the following EU Directives:

— Industrial Emissions Directive (2010/75/EU) [2];

— Water Framework Directive (2000/60/EC) [3];

— Marine Strategy Framework Directive (2008/56/EC) [4];

— Drinking Water Directive (98/83/EC) [5];

— Technical Specifications for Chemical Analysis and Monitoring of Water Status (2009/90/EC) [6].

1 Scope

This document specifies general requirements and performance test procedures for portable and fixed position measuring devices that are used in an in-line or online operating position to measure physical and chemical measurands in water. It excludes chemical test kits and laboratory analysers.

The general requirements include functional facilities that MDs need to meet users' applications and information that needs to be included in associated documents.

The test procedures specify uniform methods to be used when determining key performance characteristics of MDs. The performance tests comprise testing carried out under laboratory and field conditions. It is recognized that for some devices certain test procedures are not applicable.

Statistical procedures are defined for evaluation of the test data.

Example values for performance characteristics for a selection of MDs for monitoring waste water effluents and receiving waters are detailed in Annex A for guidance.

This document requires the manufacturer of a MD to provide more technical data for verification than does EN ISO 15839:2006 [7]. Consequently, EN ISO 15839 [7] will be of greater assistance to manufacturers wishing to characterize a new device whereas this document is more focussed on user requirements for the verification of manufacturer's claims.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 5814:2012, *Water quality - Determination of dissolved oxygen - Electrochemical probe method (ISO 5814:2012)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
measuring device
MD
device, used in an in-line or on-line operating position, which continuously (or at a given frequency) gives an output signal proportional to the value of one or more measurands in waters which it measures

Note 1 to entry: The device can be portable or fixed in position.

Note 2 to entry: The term "on-line measuring device" is often used for a MD used in an online position.

[SOURCE: EN ISO 15839:2006 [7], 3.26, modified]

3.2
portable measuring device
PMD
measuring device that can be moved from one measuring point to another and used in an in-line or on-line operating position

3.3
fixed measuring device
FMD
measuring device that can be fixed in position and used in an in-line or on-line operating position

3.4
sensor
electronic device that senses a physical condition or chemical compound and delivers an electronic signal proportional to the observed characteristic

[SOURCE: ISO/IEC 19762:2016 [8], 06.02.08]

3.5
in-line measuring device
in situ measuring device
system of automatic measurement in which at least the sensor is sited in the body of water

[SOURCE: ISO 6107-2:2006[9], **54**, modified — term "analysis" replaced by term "measuring device" and within definition "analysis" replaced by "measurement"]

3.6
on-line measuring device
system of automatic measurement in which the sample is taken from the body of water through a probe to the measuring device by means of an appropriate conduit

Note 1 to entry: Sometimes referred to as an extractive measuring device.

[SOURCE: ISO 6107-2:2006+A1:2012 [10], 71, modified — term "analysis" replaced by term "measuring device", within definition "analysing equipment" replaced by "measuring device" and Note 1 to entry added]

3.7
percentage error
error in measurement expressed as a percentage of the reference value

3.8
measurement bias
bias
estimate of a systematic measurement error

[SOURCE: ISO/IEC Guide 99:2007 [11], 2.18]

3.9
measurement repeatability
repeatability
precision under a set of repeatability conditions of measurement

[SOURCE: ISO/IEC Guide 99 [11], 2.21]

Note 1 to entry: In this standard the ability of a MD to provide closely similar indications for repeated measurements of the same measurand under the same conditions of measurement.

3.10
limit of quantification
LOQ
stated multiple of the limit of detection, for example two or three times the limit of detection, at a concentration of the measurand that can reasonably be determined with an acceptable level of accuracy and precision

Note 1 to entry: Limit of quantification can be calculated using an appropriate standard or sample, and may be obtained from the lowest calibration point on the calibration curve (excluding the blank). See ISO 6879 [12].

[SOURCE: ISO 6107-2:2006+A1:2012 [10], 61]

3.11
linearity
degree to which there is a straight-line relationship between the (mean) result of measurement (signal) and the quantity (concentration) of the component to be determined

[SOURCE: EN ISO 11885:2009 [13], 3.9, modified]

3.12
drift
slow change of output, at a constant input, of a measuring system

[SOURCE: EN ISO 15796:2005 [14], 2.8]

3.13
response time (t_{90})
time interval between the instant when a continuous measuring device is subjected to an abrupt change in measurand value and the instant when the readings cross the limits of (and remain inside) a band defined by the 90 % and the 110 % of the difference between the initial and final value of the abrupt change

[SOURCE: EN ISO 15839:2006 [7], 3.3, modified]

3.14
performance characteristics
set of parameters describing the performance of a MD

[SOURCE: EN ISO 15839:2006 [7], 3.27, modified]

3.15
measurement error
error of measurement
error
measured quantity value minus a reference quantity value

Note 1 to entry: 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 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 to entry: Measurement error should not be confused with production error or mistake.

[SOURCE: ISO/IEC Guide 99:2007 [11], 2.16]

3.16
measurement uncertainty
uncertainty of measurement
uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

Note 1 to entry: The parameter may be, for example, a standard deviation called standard measurement uncertainty (or a specified multiple of it), or the half-width of an interval, having a stated coverage probability.

Note 2 to entry: In general, for a given set of information, it is understood that the measurement uncertainty is associated with a stated quantity value attributed to the measurand. A modification of this value results in a modification of the associated uncertainty.

Note 3 to entry: Measurement uncertainty includes components arising from systematic effects, such as components associated with corrections and the assigned quantity values of measurement standards, as well as the definitional uncertainty. Sometimes estimated systematic effects are not corrected for but, instead, associated measurement uncertainty components are incorporated.

Note 4 to entry: Measurement uncertainty comprises, in general, many components. Some of these may be evaluated by Type A evaluation of measurement uncertainty from the statistical distribution of the quantity values from series of measurements and can be characterized by standard deviations. The other components, which may be evaluated by Type B evaluation of measurement uncertainty, can also be characterized by standard deviations, evaluated from probability density functions based on experience or other information.

[SOURCE: ISO/IEC Guide 99:2007 [11], 2.26]

3.17
standard measurement uncertainty
standard uncertainty of measurement
standard uncertainty
measurement uncertainty expressed as a standard deviation

[SOURCE: ISO/IEC Guide 99:2007 [11], 2.30]

3.18
combined standard measurement uncertainty
combined standard uncertainty
standard measurement uncertainty that is obtained using the individual standard measurement uncertainties associated with the input quantities in a measurement model

Note 1 to entry: In case of correlations of input quantities in a measurement model, covariances must also be taken into account when calculating the combined standard measurement uncertainty, see also ISO/IEC Guide 98-3:2008 [15], 2.3.4.

[SOURCE: ISO/IEC Guide 99:2007 [11], 2.31]

3.19
expanded measurement uncertainty
expanded uncertainty
product of a combined standard measurement uncertainty and a factor larger than the number one

Note 1 to entry: Expanded measurement uncertainty is termed "overall uncertainty" in paragraph 5 of Recommendation INC-1 (1980) (see the GUM) and simply "uncertainty" in IEC documents.

Note 2 to entry: The factor depends upon the type of probability distribution of the output quantity in a measurement model and on the selected coverage probability.

Note 3 to entry: The term "factor" in this definition refers to a coverage factor.

[SOURCE: ISO/IEC Guide 99:2007 [11], 2.35]

3.20
combined performance characteristic
combination of individual performance characteristics expressed as an expanded measurement uncertainty (with a coverage factor of 2)

3.21
test range
measuring range over which the MD is tested

3.22
output
reading, or a digital, analogue, wired or wireless electrical signal, generated by a MD in response to a measurand

3.23
rated operating condition
operating condition that must be fulfilled during measurement in order that a measuring instrument or measuring system perform as designed

Note 1 to entry: Rated operating conditions generally specify intervals of values for a quantity being measured and for any influence quantity.

[SOURCE: ISO/IEC Guide 99:2007 [11], 4.9]

3.24
interferent
physical, biological or chemical property of the sample, excluding the measurand, that affects the output signal

[SOURCE: EN ISO 15839:2006 [7], 3.16, modified]

3.25
adjustment of a measuring system
adjustment
set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured

Note 1 to entry: Types of adjustment of a measuring system include zero adjustment of a measuring system, offset adjustment, and span adjustment (sometimes called gain adjustment).

Note 2 to entry: After an adjustment of a measuring system, the measuring system usually needs to be recalibrated.

Note 3 to entry: Adjustment of a measuring system should not be confused with calibration, which is a prerequisite for adjustment.

[SOURCE: ISO/IEC Guide 99:2007 [11], 3.11]

3.26
reference method
method to be used to obtain the measurand value of the test waters, against which the readings from the MD under test can be compared

3.27
measurand
quantity intended to be measured

[SOURCE: ISO/IEC Guide 99:2007 [11], 2.3, modified]

3.28
reference operating condition
operating condition prescribed for evaluating the performance of a measuring instrument or measuring system or for comparison of measurement results

[SOURCE: ISO/IEC Guide 99:2007 [11], 4.11]

3.29
flow cell
housing within which a sensor can be held and through which the test water can be directed

3.30
up-time
fraction of the total time for which usable measuring data are available from the MD

3.31
warm-up period
interval between switching on power to the measurement circuit and the instant when the MD produces a stable value when measuring a stable measurand

4 Symbols

For the purposes of this document, the following symbols apply.

b	Bias
t_{90}	Response time
X_L	Change in error due to variations in linearity
S_r	Repeatability
X_{IN}	Change in error due to variations in interferents
X_{SC}	Change in error due to incorrect salinity compensation
X_{LX}	Change in error due to variations in incident light
X_T	Change in error due to variations in ambient temperature
X_{RH}	Change in error due to variations in relative humidity
X_{ST}	Change in error due to variations in sample temperature
X_{SQ}	Change in error due to variations in sample flow-rate
X_{SP}	Change in error due to variations in sample pressure
X_O	Change in error due to variations in output impedance
X_V	Change in error due to variations in supply voltage
X_D	Change in error due to variations in drift
W_D	Warm–up drift
U_C	Combined performance characteristic

5 Principles

The general requirements are based on experience of users' needs when operating a MD in online or in-line measuring positions in a range of applications.

The performance characteristics are parameters that identify the capability of a MD to provide reliable measurements. They are determined as measurement uncertainty and expressed as percentage error (see 3.7) except for bias and repeatability which are expressed as relative values in percentage. For low concentration measurements where the reading approaches zero the percentage error value becomes inapplicable. At low concentrations the uncertainty should be expressed as an absolute value. The tables at Annex A list example values relevant to monitoring waste water effluents and receiving waters.

Measurement reliability includes:

— the MD's measurement bias, LOQ, linearity, drift, repeatability and response time;

— operational influences arising from variations in supply voltage, output impedance, sample temperature, sample flow-rate and sample pressure;

— environmental influences arising from variations in ambient temperature, relative humidity, interferents and incident light.

The overall measurement reliability of a MD is captured by bringing the individual performance characteristics together in the form of a combined performance characteristic expressed as measurement uncertainty.

The laboratory performance tests are designed to determine the values for the specified performance characteristics in a systematic and consistent way. Laboratory testing is used to determine each performance characteristic in turn in a controlled environment.

Statistical procedures are defined for evaluation of the laboratory test data to calculate the individual performance characteristic measurement standard uncertainties, u, and the combined performance characteristic measurement uncertainty, U_C. They are based on ISO/IEC Guide98-3 to the Expression of Uncertainty in Measurement (GUM). The procedure for calculating the combined performance characteristic measurement uncertainty involves converting the individual performance characteristic uncertainties to standard uncertainties. This takes account of the probable distribution of errors. In the GUM, standard uncertainties are combined using a root sum of squares with due account taken of the contribution of each component through the use of sensitivity co-efficients. To determine sensitivity co-efficients, it is necessary to know the functions by which each component contributes to overall error. In the case of MD testing this will rarely be known. Hence for the purposes of this standard, the sensitivity co-efficients are all taken as 1.

The combined performance characteristic, U_C, is expressed as an expanded uncertainty. The expanded uncertainty, (U), is obtained by multiplying the standard uncertainty by a coverage factor. The coverage factor is determined by the confidence level. This Standard uses a 95 % confidence with a coverage factor assumed to be 2.

Field testing is carried out to demonstrate the MD's performance is maintained under representative operational conditions. FMD field testing is carried out on an application that is representative of the intended use of the FMD. PMD field testing involves the repeated use of the PMD on several applications that are representative of the intended use of the PMD. A field trial can be a dedicated trial, or part of an acceptance trial, or in the case of FMD, be carried out on a device that has already been installed and is in operational use. The field performance tests are designed to determine the MD's measurement error, the change in response time and variation in sensitivity between the beginning and end of the trial, the maintenance requirements and up-time. Response time and variation in sensitivity are indicators of how a MD performs in real conditions.

During the field test the measurement error test is carried out by comparison with a reference method. Statistical procedures are defined for the evaluation of the measurement error test data. For each measurement pair the difference between the reference value and the MD's reading is calculated as % error (except for pH and temperature for which absolute values apply). The value of the measurement error corresponding to the 90th percentile is calculated.

6 General requirements

6.1 Requirements for MDs

Unless otherwise stated a MD shall have the following:

a) a unique designation that unambiguously identifies it (e.g. model, serial number);

b) for a FMD a means of protection against inadvertent or unauthorized access to the control functions;

c) an output signal and/or display;

d) the units of measurement should be appropriate to the measurand being measured and should not require reference to a calibration chart or table or visual comparison;