

**Utsläpp och utomhusluft – Bestämning av
masskoncentrationen av kolmonoxid (CO) –
Referensmetod: Icke-dispersiv infraröd
spektroskopi**

**Stationary source emissions – Determination
of the mass concentration of carbon monoxide
(CO) – Reference method: Non-dispersive
infrared spectrometry**

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Emissions de sources fixes - Détermination de la concentration massique en monoxyde de carbone (CO) - Méthode de référence : spectrométrie infrarouge non dispersive

Emissionen aus stationären Quellen - Bestimmung der Massenkonzentration von Kohlenmonoxid (CO) - Referenzverfahren: Nicht-dispersive Infrarotspektrometrie

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Foreword

This document (EN 15058:2006) has been prepared by Technical Committee CEN/TC 264 "Air quality", 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of an identical text or by endorsement, at the latest by November 2006, and conflicting national standards shall be withdrawn at the latest by November 2006.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EN 15058:2006 (E)

1 Scope

This European Standard specifies the Standard Reference Method (SRM) for sampling, and determining carbon monoxide content in ducts and stacks emitting to atmosphere. It describes the Non Dispersive Infra-Red (NDIR) analytical technique, including the sampling system and sample gas conditioning system, to determine CO in flue gases. This European Standard is the reference method for periodic monitoring and for calibration or control of Automatic Measuring Systems (AMS) permanently installed on a stack, for regulatory purposes or other purposes. To be used as the SRM, it is necessary to demonstrate that the performance characteristics of the method are lower than the performance criteria defined in this European standard and that the overall uncertainty of the method is less than $\pm 6\%$ relative at the daily Emission Limit Value (ELV).

NOTE When the NDIR method is used as an AMS, refer to EN 14181 and other relevant standards provided by CEN TC 264.

It is necessary for anybody who would like to use an Alternative Method instead of this Standard Reference Method to work out the demonstration of the equivalence according to the Technical Specification TS 14793, providing that his capability to carry out this demonstration is officially recognised by his national accreditation body or law.

This Standard Reference Method has been evaluated during field tests on waste incineration, co-incineration installations and large combustion plants. It has been validated for CO concentrations with sampling periods of 30 min in the range of 0 mg/m³ to 400 mg/m³ for large combustion plants and 0 mg/m³ – 740 mg/m³ for waste and co-incineration. For waste incineration plants, Council Directive 2000/76/EC lays down emission values which are expressed in mg/m³, on dry basis at a specified value of O₂ and at reference conditions of 273 K and 101,3 kPa.

2 Normative references

The following referenced documents are indispensable for the application 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.

ENV 13005, *Guide to the expression of uncertainty in measurement*.

CEN/TS 14793: *Stationary source emission - Intralaboratory validation procedure for an alternative method compared to a reference method*.

EN ISO 14956, *Air Quality – Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty* (ISO 14956:2002).

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*.

ISO 5725-6:1994, *Accuracy (trueness and precision) of measurement methods and results - Part 6: Use in practice of accuracy values*.

VIM 1994, *International vocabulary of basic and general terms in metrology*.

3 Terms and definitions

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

**3.1
adjustment (of a measuring system)**

operation of bringing a measuring system into a state of performance suitable for its use

[VIM 4.30]

**3.2
ambient temperature**

temperature of the air around the measuring system

**3.3
automatic measuring system
(AMS)**

measuring system permanently installed on site for continuous monitoring of emissions

NOTE 1 An AMS is a method which is traceable to a reference method.

NOTE 2 Apart from the analyser, an AMS includes facilities for taking samples (e.g. probe, sample gas lines, flow meters, regulators, delivery pumps) and for sample conditioning (e.g. dust filter, moisture removal devices, converters, diluters). This definition also includes testing and adjusting devices that are required for regular functional checks.

**3.4
calibration**

statistical relationship between values of the measurand indicated by the measuring system (AMS) and the corresponding values given by the standard reference method (SRM) used during the same period of time and giving a representative measurement on the same sampling plane

NOTE The result of calibration permits to establish the relationship between the values of the SRM and the AMS (calibration function).

**3.5
drift**

difference between two zero (zero drift) or span readings (span drift) at the beginning and at the end of a measuring period

**3.6
emission limit value
(ELV)**

emission limit value according to EU Directives on the basis of 30 min, 1 hour or 1 day

**3.7
influence quantity**

quantity that is not the measurand but that affects the result of the measurement

[adapted VIM 2.7]

EXAMPLES

- ambient temperature;
- atmospheric pressure;
- presence of interfering gases in the flue gas matrix;
- pressure of the gas sample.

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3.8 interference

negative or positive effect upon the response of the measuring system, due to a component of the sample that is not the measurand

3.9 lack of fit

systematic deviation within the range of application between the measurement result obtained by applying the calibration function to the observed response of the measuring system measuring test gases and the corresponding accepted value of such test gases

NOTE 1 Lack of fit may be a function of the measurement result.

NOTE 2 The expression "lack of fit" is often replaced in everyday language by "linearity" or "deviation from linearity".

3.10 measurand

particular quantity subject to measurement

[VIM 2.6]

3.11 measuring system

complete set of measuring instruments and other equipment assembled to carry out specified measurements

[VIM 4.5]

3.12 performance characteristic

one of the quantities (described by values, tolerances, range...) assigned to equipment in order to define its performance

3.13 repeatability in the laboratory

closeness of the agreement between the results of successive measurements of the same measurand carried out under the same conditions of measurement

NOTE 1 Repeatability conditions include:

- same measurement procedure;
- same laboratory;
- same measuring system, used under the same conditions;
- same location;
- repetition over a short period of time.

NOTE 2 Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results.

In this European Standard the repeatability is expressed as a value with a level of confidence of 95 %.

[VIM 3.6]

3.14 repeatability in the field

closeness of the agreement between the results of simultaneous measurements of the same measurand carried out with two sets of equipment under the same conditions of measurement

NOTE 1 These conditions include:

- same measurement procedure;
- two sets of equipment, the performance of which fulfils the requirements of the reference method, used under the same conditions;
- same location;
- implemented by the same laboratory;
- typically calculated on short periods of time in order to avoid the effect of changes of influence parameters (e.g. 30 min).

NOTE 2 Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results.

In this European Standard the repeatability under field conditions is expressed as a value with a level of confidence of 95 %.

3.15

reproducibility in the field

closeness of the agreement between the results of simultaneous measurements of the same measurand carried out using several sets of equipment under the same conditions of measurement

NOTE 1 These conditions are called field reproducibility conditions and include:

- same measurement procedure;
- several sets of equipment, the performance of which fulfils the requirements of the reference method, used under the same conditions;
- same location;
- implemented by several laboratories.

NOTE 2 Reproducibility may be expressed quantitatively in terms of the dispersion characteristics of the results.

In this European Standard the reproducibility under field conditions is expressed as a value with a level of confidence of 95 %.

3.16

residence time in the measuring system

time period for the sampled gas to be transported from the inlet of the probe to the inlet of the measurement cell

3.17

response time

time interval between the instant when a stimulus is subjected to a specified abrupt change and the instant when the response reaches and remains within specified limits around its final steady value

NOTE By convention time taken for the output signal to pass from 0 % to 90 % of the final change.

[VIM 5.17]

3.18

sampling location

specific area close to the sampling plane where the measurement devices are set up

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3.19 sampling plane

plane normal to the centreline of the duct at the sampling position

[EN 13284-1]

3.20 sampling point

specific position on a sampling line at which a sample is extracted

[EN 13284-1]

3.21 span gas

test gas used to adjust and check a specific point on the response line of the measuring system

NOTE This concentration is often chosen around 80 % of the upper limit of the range or around the emission limit value.

3.22 standard reference method (SRM)

measurement method recognised by experts and taken as a reference by convention, which gives, or is presumed to give, the accepted reference value of the concentration of the measurand (3.10) to be measured

3.23 uncertainty

parameter associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand

3.23.1 standard uncertainty

u
uncertainty of the result of a measurement expressed as a standard deviation u

3.23.2 expanded uncertainty

U
quantity defining a level of confidence about the result of a measurement that may be expected to encompass a specific fraction of the distribution of values that could reasonably be attributed to a measurand

$$U = k \times u$$

NOTE In this European Standard, the expanded uncertainty is calculated with a coverage factor of $k = 2$, and with a level of confidence of 95 %.

3.23.3 combined uncertainty

u_c
standard uncertainty u_c attached to the measurement result calculated by combination of several standard uncertainties according to GUM.

3.23.4 overall uncertainty

U_c
expanded combined standard uncertainty attached to the measurement result calculated according to GUM

$$U_c = k \times u_c$$

3.24

uncertainty budget

calculation table combining all the sources of uncertainty according to EN ISO 14956 or ENV 13005 in order to calculate the overall uncertainty of the method at a specified value

4 Principle

4.1 General

This European standard describes the reference method for sampling, and determining the carbon monoxide (CO) concentration in ducts and stacks emitting to atmosphere by means of an automatic analyser using Non Dispersive Infra-Red (NDIR) absorption principle. The specific components and the requirements for the sampling system and the NDIR analyser are described in Clause 6. A number of performance characteristics with associated minimum performance criteria are given for the analyser. These performance characteristics and the overall uncertainty of the method shall meet the performance criteria given in this European Standard. Requirements and recommendations for quality assurance and quality control are given for measurements in the field (see Table 1 in 7.2).

4.2 Measuring principle

CO concentration is measured with use of non-dispersive infrared methods. The attenuation of infrared light passing through a sample cell is a measure of the concentration of CO in the cell, according to the Lambert-Beer law. Not only CO but also most hetero-atomic molecules absorb infrared light, in particular water and CO₂ have broad bands that can interfere with the measurement of CO. Different technical solutions have been developed to suppress cross-sensitivity, instability and drift in order to design automatic monitoring systems with acceptable properties. For instance:

- measuring IR absorption of a specific wavelength (4,7 µm for CO);
- dual-cell monitors, using a reference cell filled with clean air (compensation for drift);
- gas filter correlation, “measuring” over a range of wavelengths.

Special attention shall be paid to infrared radiation absorbing gases such as water vapour, carbon dioxide, nitrous oxide and hydrocarbons.

NDIR analysers are combined with an extractive sampling system and a gas conditioning system. A representative sample of gas is taken from the stack with a sampling probe and conveyed to the analyser through the sampling line and gas conditioning system. The values from the analyser are recorded and/or stored by means of electronic data processing.

The concentration of carbon monoxide is measured in volume/volume units (if the analyser is calibrated using a volume/volume standard). The final results for reporting are expressed in milligrams per cubic meter using standard conversion factors (see Clause 10).