SLOVENSKI STANDARD
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Merjenje tokov CO2 - Vzorčenje in analiza za transport po cevovodih

Measurement of CO2 streams - Sampling and analysis for pipeline transportation

Quantifizierung und Verifizierung von Kohlenstoffdioxid in der gesamten CCS-Wertschöpfungskette

Mesurage des flux de CO2 - Échantillonnage et analyse pour les systèmes de transport par conduites

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Quantifizierung und Verifizierung von Kohlenstoffdioxid in der gesamten CCS-Wertschöpfungskette

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 18329:2026) has been prepared by Technical Committee CEN/TC 474 “Carbon dioxide Capture, transportation, Utilisation, and Storage (CCUS)”, the secretariat of which is held by NEN.

This document is currently submitted to the CEN Enquiry.

Introduction

The document provides requirements and recommendations for the selection, operation, and quality assurance of sampling and analysis measurement equipment.

The information presented in this document is based on the best available knowledge at the time of writing, incorporating both experimental and operational experience where possible. In areas where such experience is not yet available, a conservative approach has been adopted, following common practices established across similar industries. As further experience is gained, it is expected that this document will be revised accordingly.

1 Scope

This document specifies requirements and recommendations for measuring the composition of CO_2 streams during post capture pipeline transportation.

The primary objective of this document is to establish standardized technical requirements and recommendations necessary for implementing regulations, commercial contracts, inventory ownership and fiscal transactions within the framework of Carbon Capture and Storage (CCS).

This document includes measurements up to the storage injection points but does not cover Measurement, Monitoring, and Verification (MMV) once the CO_2 has entered the geological storage complex.

The differentiation between biogenic and non-biogenic CO_2 in a CO_2 stream is recognized as highly relevant for accounting purposes. However, the measurement methodologies for the biogenic CO_2 fraction fall outside the scope of this document, which covers post-capture pipeline transportation. This document is not intended to differentiate between biogenic CO_2 and CO_2 produced from non-biogenic sources.

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.

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 14167:2018, *Gas analysis — General quality aspects and metrological traceability of calibration gas mixtures*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

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

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

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

3.1.1
adjustment of a measuring instrument
operation of bringing a measuring instrument into a state of performance suitable for its use

Note 1 to entry: Adjustment can be automatic, semi-automatic, or manual.

[SOURCE: EN ISO 14532:2017]

3.1.2
analysis of CO_2 stream
measurement methods and techniques for determining the *composition of a CO_2 stream* (3.1.14)

[SOURCE: EN ISO 14532:2017, 2.5.2.1.4, modified — "CO_2 stream" replaces "gas".]

3.1.3
analytical unit
analyser
assembly which enables qualitative and/or quantitative determinations (measurements) of substances on the basis of their chemical or physical properties

Note 1 to entry: A typical assembly can comprise:

— connectors/manifold permitting the introduction and removal of a sample and/or calibration gas(es),

— a measuring cell which, from the physical or chemical properties of the components present in the sample, gives signals allowing their identification or measurement, and

— signal processing devices (e.g. amplifiers, integrators, recorders) and/or data processing devices.

Note 2 to entry: Assembly does not comprise the *sampling system.*

[SOURCE: ISO 7504:2015, 8.3.1, modified — "connectors/manifold" replaces "lines" in Note 1 to entry; Note 2 to entry added.]

3.1.4
analytical unit cycle time
analyser cycle time
time required for the analytical unit to process and analyse the sample after it has reached the unit and to generate a measurement output signal

Note 1 to entry: This includes the time taken for processing the analytical unit *response* (3.1.48) and/or the data analysis within the analytical unit, but does not account for the time required for the transmission of the measurement output signal outside the analytical unit.

3.1.5
analysis function
relationship describing component content as a function of instrument response

Note 1 to entry: It refers to the analysis function of the analytical unit for composition determination.

[SOURCE: EN ISO 10723:2012, 3.8, modified — Note 1 to entry added.]

3.1.6
blank material
material which contains no, or as little as possible, of the analyte of interest used in measurement to establish a blank indication

[SOURCE: 'blank material' in IUPAC Compendium of Chemical Terminology, 5th ed. International Union of Pure and Applied Chemistry; 2025. Online version 5.0.0, 2025. https://doi.org/10.1351/goldbook.08010]

3.1.7
bubble point pressure
pressure of the saturated liquid at a given composition and temperature

[SOURCE: EN ISO 27913:2025, 3.3]

3.1.8
calibration
operation that, under specified conditions, in a first step establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step uses this information to establish a relation for obtaining a measurement result from an indication

Note 1 to entry: A calibration can be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it consists of an additive or multiplicative correction of the indication with associated measurement uncertainty.

Note 2 to entry: Calibration should not be confused with adjustment of a measuring system, often mistakenly called "self-calibration", nor with verification of calibration.

Note 3 to entry: Often, the first step alone in the above definition is perceived as being calibration.

[SOURCE: EN ISO 14532:2017, 2.5.1.1]

3.1.9
calibration gas mixture
CGM
gas mixture whose composition is sufficiently well established and stable to be used as a *working measurement standard* (3.1.73) of composition

[SOURCE: EN ISO 10723:2012, 3.4, modified — Note 1 to entry deleted.]

3.1.10
calibration function
relationship describing instrument response as a function of component content established by calibration

Note 1 to entry: It refers to the calibration function of the analytical unit for composition determination.

[SOURCE: EN ISO 10723:2012, 3.7, modified — Note 1 to entry added; "established by calibration" added.]

3.1.11
carbon dioxide stream
CO_2 stream
stream consisting overwhelmingly of carbon dioxide (usually > 95 mol% CO_2)

3.1.12
certified reference gas mixture
CRM
reference gas mixture, characterized by a metrologically valid procedure for one or more specified properties, accompanied by a certificate that provides the value of the specified property, its associated uncertainty, and a statement of metrological traceability

Note 1 to entry: The above definition is based on the definition of "certified reference material" in ISO Guide 35:2017. "Certified reference material" is a generic term; "certified reference gas mixture" is more suited to this application.

Note 2 to entry: Metrologically valid procedures for the production and certification of reference materials (such as certified reference gas mixtures) are given in, among others, ISO Guide 34:2009 and ISO Guide 35:2017.

Note 3 to entry: ISO Guide 31:2015 gives guidance on the contents of certificates.

[SOURCE: EN ISO 10723:2012, 3.2]

3.1.13
component
chemical entity at a defined physical state present in a material or in a mixture

[SOURCE: ISO 7504:2015, 3.3]

3.1.14
composition of CO_2 stream
identity and *content* (3.1.16) of each of the *components* (3.1.13) that constitute a particular CO_2 stream

3.1.15
consequence
outcome of an event affecting objectives

Note 1 to entry: A consequence can be certain or uncertain and can have positive or negative direct or indirect effects on objectives.

Note 2 to entry: Consequences can be expressed qualitatively or quantitatively.

Note 3 to entry: Any consequence can escalate through cascading and cumulative effects.

[SOURCE: ISO 31000:2018, 3.6]

3.1.16
content
mass fraction, *volume fraction, mole fraction* (3.1.37), *mass concentration*, *molar concentration, volume concentration* (3.1.38) of a *component* (3.1.13) in a CO_2 stream

Note 1 to entry: See EN ISO 14912:2025 for further information about this concept.

3.1.17
continuous sampling
direct sampling (3.1.21) taken continuously from a CO_2 stream with a constant flow rate in a certain period of time

[SOURCE: ISO 19230:2020, 3.17, modified — "CO_2 stream" replaces "a stream of material".]

3.1.18
critical point
highest temperature and pressure at which a pure substance (e.g. CO_2) can exist as a gas and a liquid in equilibrium

Note 1 to entry: For a multicomponent fluid mixture of a given composition, the critical point is the merge of the bubble point curve and the dew point curve.

Note 2 to entry: The critical point can be established with the *critical pressure* and the *critical temperature*.

[SOURCE: EN ISO 27913:2025, 3.6]

3.1.19
critical pressure
vapour pressure at the *critical temperature* (3.1.20)

Note 1 to entry: The critical pressure for pure CO_2 is 7,38 MPa.

[SOURCE: EN ISO 27913:2025, 3.7]

3.1.20
critical temperature
pure substance temperature above which liquid cannot be formed simply by increasing the pressure

Note 1 to entry: The critical temperature of pure CO_2 is 304,13 K (equivalent to 30,98 °C).

Note 2 to entry: For *CO_2 streams* (3.1.11), phase transitions can still occur above critical temperature.

[SOURCE: EN ISO 27913:2025, 3.8]

3.1.21
direct sampling
sampling (3.1.53) in situations where there is a direct connection between the CO_2 stream to be sampled and the analytical unit

[SOURCE: EN ISO 10715:2022, 3.5, modified — "the CO_2 stream" replaces "the natural gas".]

3.1.22
dense phase
CO_2 streams in the single-phase fluid state above a density of 500 kg/m^3

Note 1 to entry: Dense phase is an engineering term and not a thermodynamic phase (i.e. liquid, gas, solid, and supercritical).

[SOURCE: EN ISO 27913:2025, 3.9, modified — "understood to be CO_2 streams" replaces "understood to be CO_2 or CO_2 streams"; Note 1 to entry added.]

3.1.23
dew point pressure
pressure on the saturated vapour line

[SOURCE: EN ISO 27913:2025, 3.10]

3.1.24
extended working range
range of parameters for which the correlation has been developed, but outside the range for which the calibration function has been validated

[SOURCE: EN ISO 14532:2017, 2.5.1.8]

3.1.25
floating piston cylinder
sample container (3.1.52) that has a moving piston separating the sample from a precharge gas

Note 1 to entry: The pressures are in balance on both sides of the piston.

[SOURCE: ISO 19230:2020, 3.4]

3.1.26
flow assurance
engineering discipline that is required to understand the behaviour of fluids inside pipelines, at flowing and static conditions

[SOURCE: EN ISO 27913:2025, 3.13]

3.1.27
in-line measurement
composition measurement where the CO_2 stream is analysed directly within the pipeline, without *sampling* (3.1.53)

3.1.28
incremental sampler
sampler which accumulates a series of *spot samples* (3.1.66) into one composite sample

[SOURCE: EN ISO 10715:2022, 3.11, modified — "the CO_2 stream" replaces "the natural gas".]

3.1.29
incremental sampling
indirect sampling (3.1.30) by accumulating a series of *spot samples* (3.1.66) into one composite sample

3.1.30
indirect sampling
sampling (3.1.53) in situations where there is no direct connection between the the CO_2 stream to be sampled and the analytical unit

[SOURCE: EN ISO 10715:2022, 3.11, modified — "the CO_2 stream" replaces "the natural gas".]

3.1.31
intermittent sampling
direct sampling (3.1.21) from a CO_2 stream with predetermined intervals

[SOURCE: EN ISO 10715:2022, 3.11, modified — "a CO_2 stream" replaces "a stream of material".]

3.1.32
lag time
time taken for a *representative sample* (3.1.46) to enter the analytical unit from the *sample point*

[SOURCE: ISO 19230:2020, 3.24, modified — "analytical unit" replaces "instrument"; "from the *sampling point*" added.]

3.1.33
likelihood
chance of something happening

Note 1 to entry: In *risk management* (3.1.51) terminology, the word "likelihood" is used to refer to the chance of something happening, whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively, and described using general terms or mathematically (such as a probability or a frequency over a given time period).

Note 2 to entry: The English term "likelihood" does not have a direct equivalent in some languages; instead, the equivalent of the term "probability" is often used. However, in English, "probability" is often narrowly interpreted as a mathematical term. Therefore, in risk management terminology, "likelihood" is used with the intent that it should have the same broad interpretation as the term "probability" has in many languages other than English.

[SOURCE: ISO 31000:2018, 3.7]

3.1.34
Limit of Detection
LOD
detection limit
derived from the smallest measure, that can be detected with reasonable certainty for a given analytical procedure

Note 1 to entry: The value is given by the equation:

$$LOD = \bar{y}_b + k\ \sigma_b$$

where

$\bar{y}_b$ is the mean of the blank measures,

σ_b is the standard deviation of the blank measures, and

k is a numerical factor chosen according to the confidence level desired.

[SOURCE: 'limit of detection' in IUPAC Compendium of Chemical Terminology, 5th ed. International Union of Pure and Applied Chemistry; 2025. Online version 5.0.0, 2025. https://doi.org/10.1351/goldbook.L03540]

3.1.35
Limit of Quantification
LOQ
smallest or largest measured quantity value, obtained by a given measurement procedure, which fulfils a requirement of fitness for purpose

Note 1 to entry: The quantity measured is usually a mass fraction or a concentration but can also be for example, a mass or an amount of substance.

Note 2 to entry: The requirement can, for example, be a standard deviation under repeatability conditions of measurement or a measurement uncertainty.

Note 3 to entry: The smallest and largest measured quantity values correspond to the *Lower Limit of Quantification (LLOQ)* and the *Upper Limit of Quantification (ULOQ)*, respectively. The interval between the LLOQ and ULOQ is the *working interval* (3.1.74).

Note 4 to entry: If the LLOQ is estimated as a multiple of the standard deviation of measured values of a *blank material* (3.1.6) (or one spiked with a small aliquot of the component) obtained under repeatability conditions of measurement, it is important to document the multiplication factor, which may be 5, 6, or 10, applied so that different values stated for the LLOQ can be compared.

[SOURCE: IUPAC Compendium of Chemical Terminology, 5th ed. International Union of Pure and Applied Chemistry; 2025. Online version 5.0.0, 2025. https://doi.org/10.1351/goldbook.08022]

3.1.36
Lower Limit of Quantification
LLOQ
smallest measured quantity value, obtained by a given measurement procedure, which fulfils a requirement of fitness for purpose

3.1.37
mass (volume)
(mole) fraction
quotient of the mass [volume (under specified conditions of pressure and temperature)] (amount of substance) of a *component* A to the sum of the masses [sum of the volumes (intended prior to mixing under specified conditions of pressure and temperature)] (sum of the amounts of substances) of all components of the CO_2 stream

Note 1 to entry: Mole fraction and amount-of-substance fraction are interchangeable terms.

[SOURCE: EN ISO 14532:2017, 2.5.2.1.1, modified — "CO_2 stream" replaces "gas mixture"; Note 1 to entry added.]

3.1.38
mass (molar)
(volume) concentration
quotient of the mass [volume (under specified conditions of pressure and temperature)] (amount of substance) of each *component* (3.1.13) to the volume of the CO_2 stream under specified conditions of pressure and temperature

Note 1 to entry: The mass, molar, and volume concentrations depend on the pressure and temperature of the CO_2 stream.

Note 2 to entry: Molar concentration and amount-of-substance concentration are interchangeable terms.

[SOURCE: EN ISO 14532:2017, 2.5.2.1.2, modified — "CO_2 stream" replaces "gas mixture"; Note 2 to entry added.]

3.1.39
measurement system response time
measuring system response time
overall time it takes for the composition *measuring system* (3.1.40) to measure the concentration of a specified component

Note 1 to entry: It consists of the *lag time* (3.1.32) and the *analytical unit cycle time* (3.1.4).

3.1.40
measuring system
set of one or more measuring instruments and often other devices, including any reagent and supply, assembled and adapted to give information used to generate measured quantity values within specified intervals for quantities of specified kinds

Note 1 to entry: Composition measuring system include the *analytical unit* (3.1.3) and the *sampling system* (3.1.63).

[SOURCE: JCGM 200:2012, modified — Note 1 to entry added.]

3.1.41
minimum design temperature
lowest possible temperature to which the equipment or system may reasonably be exposed locally during installation and operation

[SOURCE: EN ISO 27913:2025, 3.19]