
**Air quality — Measurement of
stationary source emissions —
Requirements for measurement
sections and sites and for the
measurement objective, plan and
report**

*Qualité de l'air — Mesurage des émissions de sources fixes —
Exigences relatives aux sections et sites de mesurage et relatives à
l'objectif, au plan et au rapport de mesurage*





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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by European Committee for Standardization (CEN) (as EN 15259:2007) and was adopted without modification other than those given below, under a special "fast-track procedure", by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 1, *Stationary source emission*, in parallel with its approval by the ISO member bodies:

- any "EN ISO xxxx" references have been changed to "ISO xxxx" references;
- "n" has been corrected to " n_d " in [Formulae \(D.6\)](#) and [\(D.7\)](#);
- the black spot from the center of the circle has been removed in Figure D.2.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document defines requirements for

- a) measurement sections and sites at waste gas ducts of industrial plants and
- b) measurement objective, plan and report.

This document is intended to ensure reliable and comparable results when used in conjunction with reference methods such as those that have been developed by CEN/TC 264.

This document is important to plant designers, constructors, plant operators, testing laboratories, accreditation bodies and regulators.

This document requires the specification of a measurement objective. There can be various objectives for measuring emissions, e.g.

- for assessing whether industrial installations are operating in compliance with IPPC permits^[1] (emission limit value compliance assessment),
- for emissions declaration and reporting for emission inventories (e.g. local, national and international e.g. for EPER^{[1],[2]}),
- for acceptance tests (proof of guarantee),
- in case of complaints,
- for obtaining a permit (e.g. following changes to process operations or plant design),
- after expiration of a set time interval to establish the condition of the plant,
- in case of interruption or disturbance of operations,
- within the framework of safety precaution investigations,
- for the calibration of continuously operating emission measuring systems,
- for checking the function of continuously operating emission measuring systems,
- to establish the cause of particular emission behaviour (e.g. the determination of the cause of a failure of the waste gas treatment to maintain the guaranteed/required level of cleaning),
- to give a prognosis of likely emission levels in special operating conditions, e.g. after changes of procedure, in case of disturbance or interruption, or in case of expansion of capacity,
- for establishing emission trading schemes^[3],
- for determining emission factors and
- for assessing available techniques for an industry sector (e.g. at company, sector and EU level)^[3].

Air quality — Measurement of stationary source emissions — Requirements for measurement sections and sites and for the measurement objective, plan and report

1 Scope

This document specifies the following requirements:

- a) requirements for measurement sections and sites with respect to performing emission measurements;
- b) requirements for the measurement objective, plan and report of emission measurements of air pollutants and reference quantities to be carried out in waste gas ducts at industrial plants.

This document applies to periodic measurements using manual or automated reference methods (RM).

This document specifies generic principles which can be applied to perform emission measurements at different plant types and to meet different measurement objectives.

NOTE The measurement objective is specified by the customer. The testing institute identifies the measurement objective and related regulatory requirements at the beginning of the measurement planning. Where measurements are being made for regulatory purposes, the customer should seek approval from the competent authority.

This document specifies procedures for taking representative samples in waste gas ducts.

This document specifies a procedure for finding the best available sampling point for automated measuring systems used for continuous monitoring of emissions.

The planning and reporting aspects of this document are applicable to emission measurements at diffusive and fugitive emission sources.

This document does not address aspects of structural safety of chimneys and ducts, construction of working platforms and safety of personnel using them.

2 Normative references

There are no normative references in this document.

3 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:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

NOTE These terms and definitions are in accordance with VIM and CEN/TS 15674.

3.1 measurement

set of operations having the object of determining a value of a quantity

[SOURCE: VIM:1993, 2.1]

Note 1 to entry: The operations can be performed automatically.

3.2 individual measurement

measurement carried out over a defined period of time

Note 1 to entry: Information on the start and end time of the measurement can be of importance, e.g. in case of parallel measurements of the reference method with an automated measuring system to be calibrated or validated.

3.3 periodic measurement

determination of a measurand at specified time intervals

Note 1 to entry: The specified time intervals may be regular (e.g. once every month) or irregular. Measurands can include the amount or physical property of an emission. Measurements are usually made using portable equipment for typically less than 24 h.

3.4 grid measurement

determination of a measurand in a given grid of measurement points in the measurement plane

3.5 measurand

particular quantity subject to measurement

[SOURCE: VIM:1993, 2.6]

Note 1 to entry: The measurand is a quantifiable property of the waste gas under test, for example mass concentration of a measured component, temperature, velocity, mass flow, oxygen content and water vapour content.

3.6 measured component

constituent of the waste gas for which a defined measurand is to be determined by measurement

3.7 reference quantity

specified physical or chemical quantity which is needed for conversion of the measurand to standard conditions

Note 1 to entry: Reference quantities are e.g. temperature ($T_{\text{ref}} = 273,15 \text{ K}$), pressure ($p_{\text{ref}} = 101,325 \text{ kPa}$), water vapour volume fraction ($h_{\text{ref}} = 0 \%$) and oxygen volume fraction o_{ref} .

3.8 reference method

RM

measurement method taken as a reference by convention, which gives the accepted reference value of the measurand

Note 1 to entry: A reference method is fully described.

Note 2 to entry: A reference method can be a manual or an automated method.

Note 3 to entry: Alternative methods can be used if equivalence to the reference method has been demonstrated.

3.9 standard reference method SRM

reference method prescribed by European or national legislation

Note 1 to entry: Standard reference methods are used e.g. to calibrate and validate AMS and for periodic measurements to check compliance with limit values.

3.10 automated measuring system AMS

measuring system permanently installed on site for continuous monitoring of emissions

Note 1 to entry: An AMS is a method which is traceable to a reference method.

[SOURCE: EN 14181:2004, 3.2]

3.11 measurement site

place on the waste gas duct in the area of the measurement plane(s) consisting of structures and technical equipment, for example working platforms, measurement ports, energy supply

Note 1 to entry: Measurement site is also known as sampling site.

3.12 measurement section

region of the waste gas duct which includes the measurement plane(s) and the inlet and outlet sections

3.13 measurement plane

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

Note 1 to entry: Measurement plane is also known as sampling plane.

3.14 hydraulic diameter

d_h

quotient of four times the area A and the perimeter P of the measurement plane

$$d_h = \frac{4 \times A}{P} \quad (1)$$

3.15 measurement line

line in the sampling plane along which the sampling points are located, bounded by the inner duct wall

Note 1 to entry: Measurement line is also known as sampling line.

3.16 measurement point

position in the measurement plane at which the sample stream is extracted or the measurement data are obtained directly

Note 1 to entry: Measurement point is also known as sampling point.

3.17 representative measurement point

measurement point at which the local mass flow density of the substance to be determined is equal to the mass flow density averaged over the measurement plane

3.18

measurement port

opening in the waste gas duct along the measurement line, through which access to the waste gas is gained

Note 1 to entry: Measurement port is also known as sampling port or access port.

3.19

clearance area

area of free space at the working platform outside the waste gas duct without obstacles in which the appropriate measuring probes are moved and handled

Note 1 to entry: See [Table 1](#).

3.20

measurement objective

scope of the measurement programme

3.21

measurement plan

structured procedure to fulfil a defined measurement objective

3.22

measurement report

report established by the testing laboratory according to the customer request and containing at least the information required in the standards applied in the measurements programme, in particular this document

3.23

site review

visit conducted by the testing laboratory before undertaking emission measurements to ensure that the physical and logistical situation is fully understood before arriving on-site to conduct work

Note 1 to entry: The site review provides information essential for determining the appropriate measurement method and development of the measurement plan.

3.24

timing

time at which samples or measurements are taken

Note 1 to entry: Timing can be crucial to obtaining a result which is relevant to the measurement objective.

3.25

sampling duration

period of time over which the sample is taken

3.26

mass concentration

c

quotient of mass m of the measured component and gas volume V

$$c = \frac{m}{V} \quad (2)$$

3.27

mass flow rate

$\dot{m}$

quotient of the mass m flowing through the measurement plane and the time t

$$\dot{m} = \frac{m}{t} \quad (3)$$

3.28**mass flow density** $\dot{m}_d$ quotient of mass flow rate $\dot{m}$ and corresponding cross-sectional area a

$$\dot{m}_d = \frac{\dot{m}}{a} \quad (4)$$

3.29**sample volumetric flow**

volumetric flow extracted from the main stream for determination of the measured component

3.30**volumetric flow rate**

quotient of the volume flowing through a plane and the time

3.31**testing laboratory**

laboratory that performs tests

Note 1 to entry: The term *testing laboratory* can be used in the sense of a legal entity, a technical entity or both.

Note 2 to entry: A testing laboratory undertakes work at the laboratory's permanent facilities, at sites away from their permanent facilities and in temporary or mobile laboratories.

Note 3 to entry: The sampling and analysis stages often occur at different locations as the analysis stage can be carried out at a permanent laboratory.

3.32**customer**

organization or person that defines the measurement objective and receives the measurement report

Note 1 to entry: Adapted from ISO 9000:2005, 3.3.5.

4 Symbols and abbreviated terms**4.1 Symbols**

a	cross-sectional area
A	area of the measurement plane
c	mass concentration
d	diameter of the duct
d_h	hydraulic diameter
F	statistical value of the F -test
h_m	measured water vapour content as volume fraction
h_{ref}	standard water vapour content as volume fraction
m	mass
$\dot{m}$	mass flow rate
$\dot{m}_d$	mass flow density

N	number of measurements
o_m	measured oxygen content as volume fraction
o_{ref}	standard oxygen content as volume fraction
P	perimeter of the measurement plane
p_m	measured pressure
p_{ref}	standard pressure
r_i	ratio of actual value $y_{i,\text{grid}}$ of the measurand in the grid and the value $y_{i,\text{ref}}$ of the reference measurement
$\bar{r}$	average of the ratios r_i
s_{grid}	standard deviation of the grid measurements
s_{inh}	standard deviation due to the inhomogeneity of the waste gas
s_{pos}	standard deviation of combined grid and reference measurement
s_{ref}	standard deviation of the reference measurements
t	time
T_m	measured temperature (absolute)
T_{ref}	standard temperature (absolute)
U_{per}	permissible expanded uncertainty
U_{pos}	expanded uncertainty of the combined grid and reference measurement
U_{ref}	expanded uncertainty related to the reference measurements at the fixed point
v	velocity of the gas in the measurement plane
V	volume
$\dot{V}$	volume flow rate
$y_{i,\text{grid}}$	measured value at the i^{th} sampling point
$y_{i,\text{ref}}$	i^{th} measured value at the reference point

4.2 Abbreviated terms

AMS	Automated measuring system
RM	Reference method
SRM	Standard reference method
SCR	Selective catalytic reduction
SNCR	Selective non catalytic reduction

5 Principles

5.1 General

Reliable and comparable results representative of the emissions in the context of the measurement objective (see [Annex G](#)) can be achieved provided that

- a) measurement section and site, preferably created at the plant design stage, are available to enable a representative sample to be taken,
- b) measurement objective and the measurement plan are available before measurements are carried out,
- c) sampling strategy is specified in the measurement plan to meet the measurement objective,
- d) report of the results is produced which includes all relevant information and
- e) competent testing laboratories are used.

NOTE Requirements on the competence of laboratories are specified in ISO/IEC 17025 and CEN/TS 15675.

[Figure 1](#) illustrates key stages of periodic measurements of emissions from stationary sources.

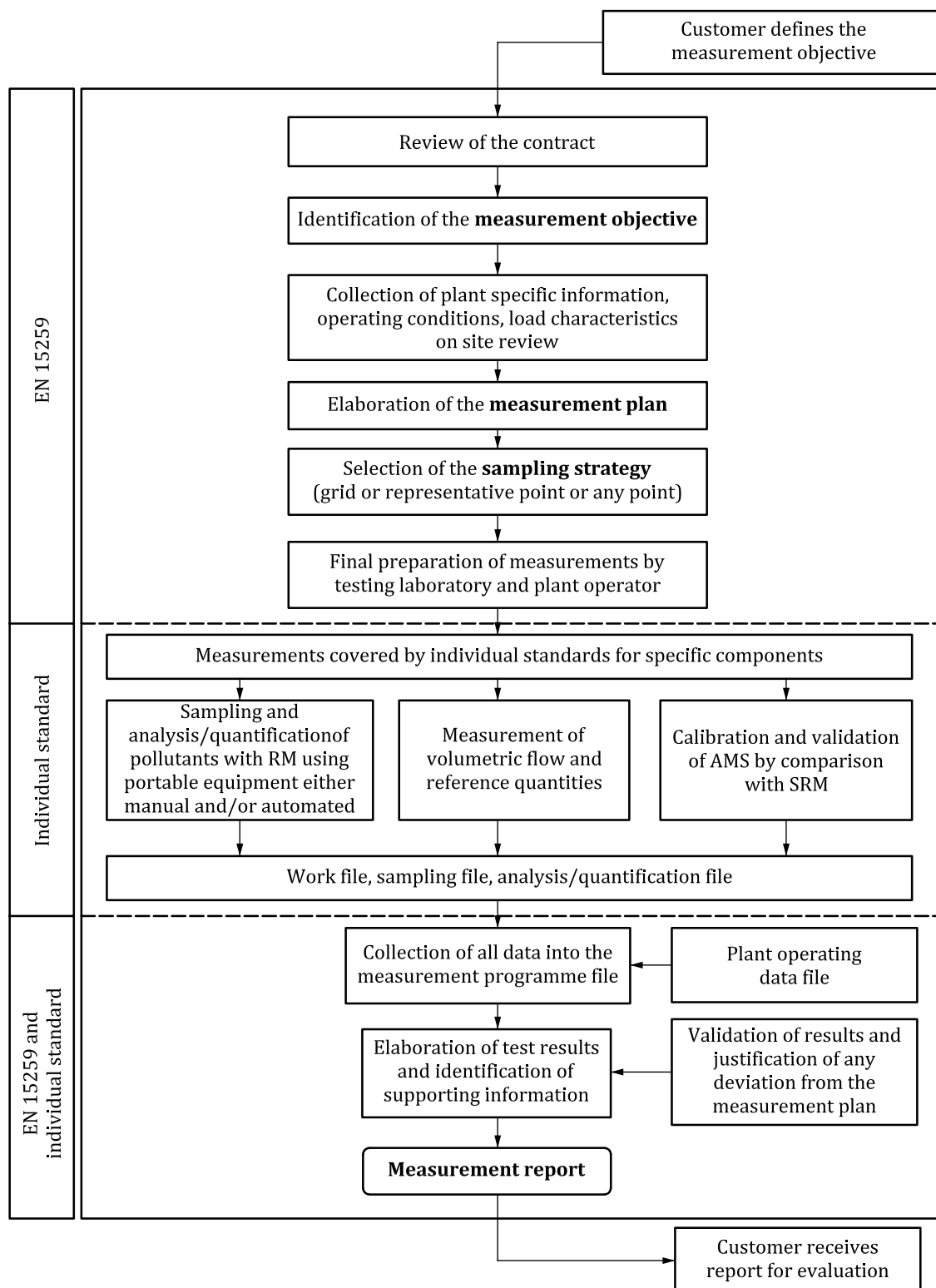


Figure 1 — Illustration of key stages of periodic measurements of emissions from stationary sources

5.2 Measurement section and measurement site

Plants designed or adapted to enable representative sampling have a section of the waste gas ducting engineered to ensure an ordered flow profile free from vortexing and backflow, where a measurement plane is located that provides a grid of sampling points sufficient to assess the distribution of

measurands and reference quantities. The measurement site allows access to the sampling plane for typical sampling equipment via a platform that enables measurement personnel to work safely and efficiently.

5.3 Measurement objective and measurement plan

The measurement objective specifies the work to be carried out, the plant operating conditions under which measurements are to be taken, any plant or process related information to be collected, working procedures to be used and any associated requirements. The results of these considerations are outlined in the measurement plan. To ensure that the measurement plan meets the measurement objective it is important to ensure that the measurement section has been assessed and any deviations from standard geometry is taken into account. Measurements are performed by suitable qualified personnel, under adequate supervision. In view of the measurement objective, simplified procedures may be used in some circumstances provided that the plant conditions are well understood and provided it is acceptable within the measurement objective. Any deviations from the standard procedures described in document s are justified and reported.

5.4 Sampling strategy

The sampling strategy ensures that a representative sample is taken. The procedures specified in [Clause 8](#) are chosen to suite the degree of homogeneity of the measurand distribution and any anticipated variability in time. Procedures are adopted to identify the number and placement of the sampling points and the sampling duration at each point.

5.5 Measurement report

The measurement report provides the results of measurement supported by a comprehensive account of the measurements, a description of the measurement objective, and the measurement plan. It also provides sufficient detail to enable the results to be traced back through the calculations to the collected basic data and process operating conditions.

6 Measurement section and measurement site

6.1 General

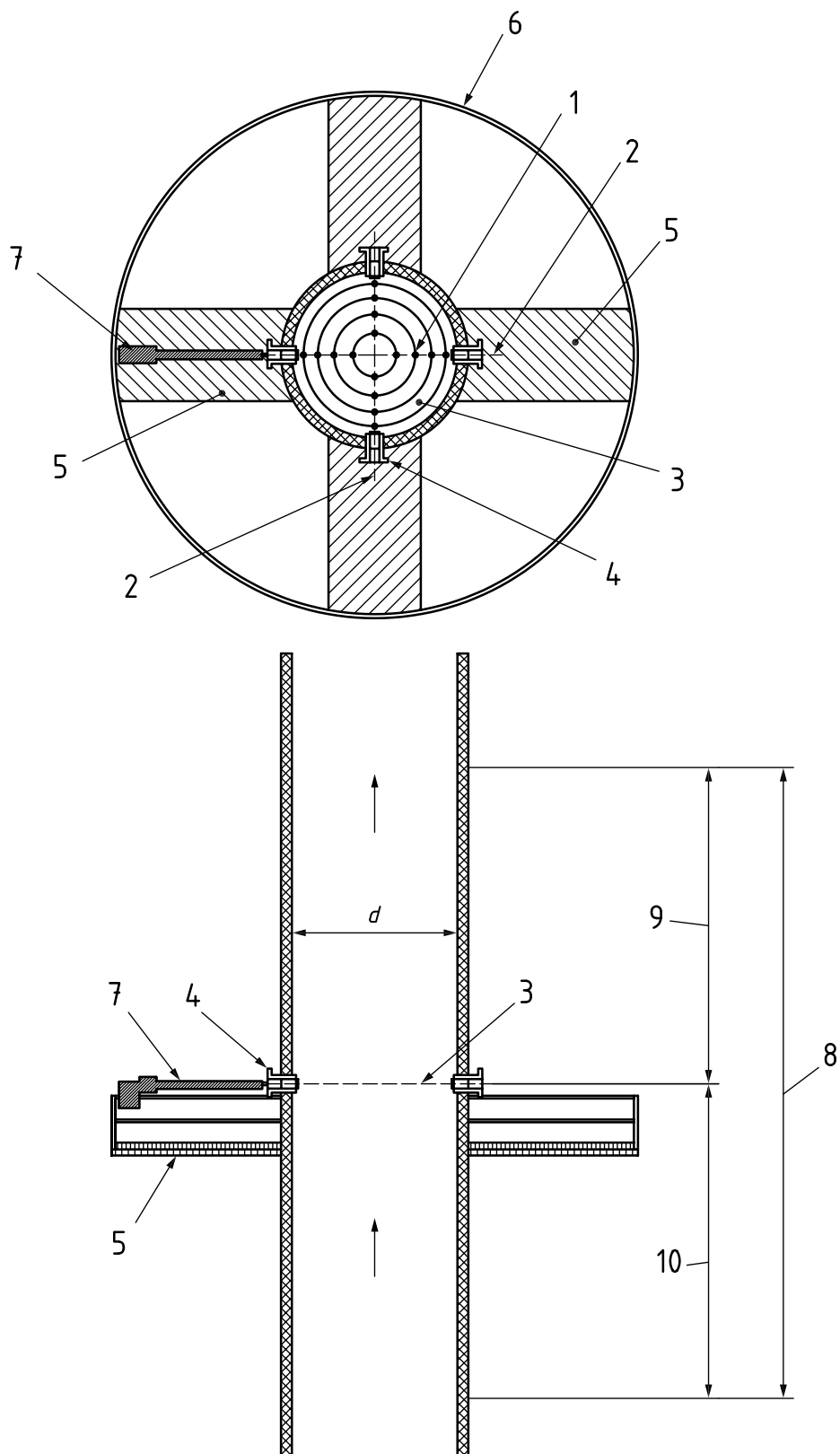
Suitable measurement sections and measurement sites are necessary to obtain reliable and comparable emission measurement results. Therefore, appropriate measurement sections and sites shall be planned when designing a plant (see [\[4\]](#)). Terms related to the measurement section and site are illustrated in [Figure 2](#).

Emission measurements in flowing gases require defined flow conditions in the measurement plane, i.e. an ordered and stable flow profile without vortexing and backflow so that the velocity and the mass concentration of the measured component in the waste gas can be determined. These requirements result from the definition of the mean concentration (see [Annex G](#)). This is the only way in which results from different measurements, for example on different plants, can be compared.

Emission measurements require appropriate measurement ports and working platforms. Therefore, the installation of measurement ports and working platforms shall be taken into account in the planning phase of a measurement section.

Specifications of regulations and official requirements shall be taken into account in the selection and specification of measurement sections and sites. Expert advice should be sought.

NOTE Aspects of structural safety of chimneys and ducts as well as construction of working platforms and safety of personnel using them are not treated in this document.



Key

- 1 measurement point
- 2 measurement line
- 3 measurement plane
- 4 measurement port
- 5 clearance area

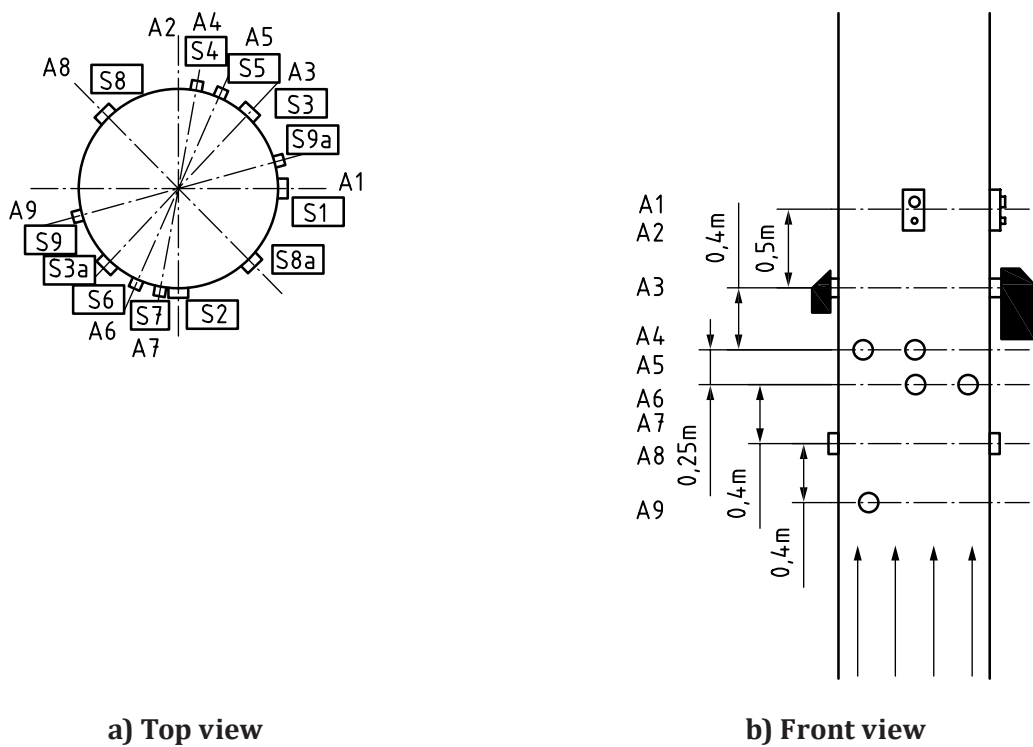
- 6 measurement site
- 7 manual sampling train
- 8 measurement section
- 9 outlet section
- 10 inlet section

Symbols

- d internal duct diameter

Figure 2 — Illustration of terms related to the measurement site and measurement section

[Figure 3](#) gives an example of mounting locations of measuring systems in a measurement section. For the different measurement activities six measurement planes are used in this example. The working platform is not represented for simplification.



Key

A	measurement line, measurement plane
A1	0°
A2	90°
A3	45°
A4	80°
A5	65°
S	measurement port
S1	reference method
S2	reference method
S3	dust AMS (optical head)
S3a	dust AMS (reflector)
S4	SO ₂ , NO, O ₂ AMS
S5	reference method

A6	245°
A7	260°
A8	135°
A9	195°
S6	HCl, total carbon, water-vapour AMS
S7	reference method
S8	volume flow AMS (transmitter)
S8a	volume flow AMS (receiver)
S9	temperature
S9a	pressure

Figure 3 — Example of the mounting location of measuring systems within a measurement section at a waste gas duct (working platform not represented for simplification)

6.2 Measurement section

6.2.1 Measurement section and measurement plane

The measurement section shall allow the sampling and execution of measurements at a suitable measurement plane.

NOTE 1 The measurement section is the region of a conducted source (e.g. waste gas duct, stack) which includes the actual measurement plane and the inlet and outlet sections.

NOTE 2 For extensive emission measurement programmes more than one measurement section and/or more than one measurement plane within each measurement section can be necessary. The requirements on measurement sections and measurement planes apply to each section and plane.

In the planning and selection of a measurement section, the following aspects in accordance with the measurement objective shall be considered:

- a) measurement section shall allow that representative samples of the emission can be taken in the measurement plane for the determination of volumetric flow and mass concentration of pollutants;

NOTE 3 The measured component can still change due to secondary reactions (degradation or synthesis) between the measurement plane and the point of escape to the open atmosphere.

- b) measurement plane shall be situated in a section of the waste gas duct (stack etc.) where homogenous flow conditions and concentrations can be expected;

NOTE 4 The requirement for homogeneous flow conditions is generally fulfilled if the measurement plane is

- as far downstream and upstream from any disturbance, which could produce a change in direction of flow (e.g. disturbances can be caused by bends, fans or partially closed dampers),
- in a section of a duct with at least five hydraulic diameters of straight duct upstream of the sampling plane and two hydraulic diameters downstream (five hydraulic diameters from the top of a stack; see [A.2](#)) and
- in a section of a duct with constant shape and cross-sectional area.

NOTE 5 Effective aerodynamic arrangements (e.g. fans, vanes, ducting design) can be required to achieve mixing of the gases before entering the (straight) duct where the measurement section is located in order to get a homogeneous concentration profile at the measurement plane, especially when several gases of different characteristics in composition, coming from different installations are collected in the same duct.

NOTE 6 It can be advisable to perform an exploratory velocity traverse before committing to a comprehensive installation.

- c) measurements at all the sampling points defined in [8.2](#) and [Annex D](#) shall prove that the gas stream at the measurement plane meets the following requirements:

- 1) angle of gas flow less than 15° with regard to duct axis;

NOTE 7 A method for the determination of the angle of gas flow is given in Annex B of EN 13284-1:2001.

- 2) no local negative flow;

- 3) minimum velocity depending on the flow rate measuring method used (for Pitot tubes a differential pressure larger than 5 Pa);

- 4) ratio of the highest to lowest local gas velocities less than 3:1;

NOTE 8 The above requirements are generally fulfilled in sections of duct with at least five hydraulic diameters of straight duct upstream of the measurement plane and two hydraulic diameters downstream (five hydraulic diameters from the top of a stack). Therefore, it is strongly recommended to design sampling locations accordingly.

- d) installation of measurement sections in vertical ducts should be preferred to installation in horizontal ducts;

NOTE 9 At high dust concentrations, for some particle fractions, sedimentation can occur in horizontal ducts. This can lead to errors in the measurement of pollutants contained in the particle fraction, e.g. heavy metals, PCDD/PCDF.

- e) measurement section shall be situated where it is possible to erect suitable working platforms with the provision of the necessary infrastructure;

- f) measurement section shall be clearly identified and labelled.

NOTE 10 Labels are intended to identify the emission source unambiguously for regulatory and other purposes.

6.2.2 Measurement ports

Measurement ports shall be provided to allow sampling at specified measurement points (see [8.2](#)).

Additional measurement ports in the same measurement plane or section shall be provided to allow measurements of other quantities (for example flow velocity, temperature, water vapour) when required by the measurement objective.

NOTE 1 In addition it can be necessary to install additional access ports for operational measurements or for instruments for continuous emission monitoring in the region of the measurement plane.

NOTE 2 Examples of suitable measurement ports are shown in [A.1](#).

Measurement ports shall be planned at the design stage of new plants or during plant modification, as later changes of the waste gas duct can be difficult and costly (if, for example, protective linings are present).

NOTE 3 The examples of [Annex A](#) have been proven suitable. Tight-sealing covers avoid hazard.

NOTE 4 If the distance between a measurement port and the opposite interior wall of the waste gas duct is large (e.g. more than 2 m), depending on the measurement objective, two opposing measurement ports can be provided per measurement line, and the platform extended accordingly.

In the case of rectangular ducts, the measurement ports should be installed on the longer side (see [Figure A.6](#)).

6.2.3 Working area and working platform

6.2.3.1 Load bearing capacity

Permanent and temporary working platforms shall have a load bearing capacity sufficient to fulfil the measurement objective.

NOTE Sampling can comprise of two to six persons with equipment weighing between 50 kg and 300 kg.

Temporary working platforms shall be tied or supported to a permanent structure to prevent collapse or overturning. They shall be checked before use in accordance with national regulations on safety at work.

6.2.3.2 Position and working space

Working platforms shall provide sufficient working area and height (working space) for the measurement objective, i.e. to manipulate the probes and operate the measuring instruments. Clearance area at the working platform shall be dimensioned appropriately. Probe introduction should not be impeded e.g. by guard fences and other built-in elements.

NOTE 1 Grid measurements require a sufficiently large working area outside the waste gas duct along the measurement lines so that the measurement points can be sampled with the appropriate probes in the measurement plane. The minimum probe length depends on the internal diameter or depth of the waste gas duct and the wall thickness.

NOTE 2 A sufficient depth of the working area is given by the sum of the internal diameter or depth of the waste gas duct and the wall thickness plus 1,5 m for flanged-on instruments (see [A.2](#)). If two opposite measurement ports are installed for one measurement line, a correspondingly smaller operating area depth is sufficient.

NOTE 3 If the waste gas has a vertical direction of flow, both with round and rectangular waste gas ducts, a working height from the platform to the measurement lines can be established, which is approximately 1,2 m to 1,5 m.

EXAMPLE [Table 1](#) shows examples of working platform areas required for the following two measurement objectives:

- a) small measurement plane and simple measurement objective (open width of the waste gas duct: 0,2 m diameter, measurement: total carbon);
- b) acceptance testing in a waste incineration plant (open width of the vertical waste gas duct: 2 m width (measurement ports) and 1,5 m depth, wall thickness: 0,3 m, measurement: total dust, total carbon, hydrogen chloride, hydrogen fluoride, sulphur dioxide, nitrogen oxides, carbon monoxide, PCDD/PCDF, heavy metals, oxygen, waste gas volumetric flow rate, waste gas pressure, waste gas temperature, carbon dioxide, water vapour).

Table 1 — Examples of working platform areas

Measurement objective	Clearance area m ²	Minimum area required for instruments, operations or movement m ²	Minimum total area m ²
a	not needed	4	4
b	6	12	18

6.3 Measurement site

6.3.1 Power supply and equipment

Power connections of an appropriate size and safeguarded in accordance with national requirement shall be installed at the measurement site. Compressed air, water connections and wastewater disposal may be necessary.

6.3.2 Safety and environmental conditions

The measurement sites shall be installed in such a way as to comply with national safety at work requirements.

At least the following aspects shall be considered:

- easy and safe access to the measurement site;
- transport means, for example hoists or lifts, ^[18] to transport measuring instruments, in the case of measurement sites which are not at ground level;
- avoidance of area of sources which emit unexpectedly, for example rupture disks, overpressure valves or steam discharges;
- avoidance of any hazard by engineering or procedural measures;
- avoidance of areas of significant positive pressure;
- availability of measures to ensure personnel carrying out the emission measurements are informed of any operating faults which would endanger them;
- possibility to accommodate the working platform or measurement site within the plant building;
- protection of the working area from heat and dust;
- protective measures, for example weather protection and heating, to ensure the necessary environmental conditions for the personnel and the equipment used.

7 Measurement objective and measurement plan

7.1 Measurement objective

7.1.1 Specification of the measurement objective

The measurement objective shall be specified by the customer.

In view of the measurement objective, simplified procedures may be adopted for small and/or frequently visited plants provided these are documented in the emission measurement report.

The measurement objective shall specify at least:

- measurement objective;
- measurement site, for details see [7.2.7](#);
- process and operating conditions, which are relevant for the emission, for details see [7.2.2](#);
- measurands (e.g. pollutant mass concentration, reference quantities, mass flow, volumetric flow) and expected values;
- period of measurement campaign, for details see [7.2.9](#);
- competence of the testing laboratory.

The measurement objective can also specify the measurement methods to be applied (for details see [7.2.6](#)) and requirements on the measurement uncertainty.

7.1.2 Identification and review of the measurement objective

The measurement objective shall be identified by the testing laboratory at the beginning of the measurement planning on the basis of the contract with the customer. This shall include any regulatory requirement.

All plant specific information which is relevant to the measurement objective shall be collected.

NOTE 1 Depending on the complexity of the measurement, plant specific information can be obtained at a site review of the plant during the basic planning, or in the case of smaller or frequently visited plants, e.g. by telephone.

NOTE 2 A site review can include a preparatory meeting with participation of e.g. a representative of the testing laboratory, the technically responsible plant personnel, a representative of the competent authority in the case of compliance monitoring, a representative of the delivery firm in the case of acceptance tests^[5].

In particular the following items shall be considered:

- a) relevant documents, e.g. contracts, permits, legal requirements;
- b) technical data of the plant including waste gas conditions, operating conditions and periods (examples are given in [B.2.3](#));

NOTE 3 These data can be acquired from measurement reports, emissions declarations, or permit documents.

- c) air pollution abatement techniques in operation (examples are given in [B.2.4](#));
- d) technical prerequisites for the measurement sites including measurement section, measurement ports, working area and platform, power supplies and other services;

- e) technical prerequisites for continuous monitoring of emissions (examples are given in [B.2.5](#)).

If the measurement objective consists of calibration of an AMS according to EN 14181, then it is also to be checked whether the requirements for calibration on the part of the device including its installation have been met, and which possibilities exist to vary the mass concentration of waste gas components with operation of the facilities;

- f) supplemental information.

Additional information collected within the framework of the measurement planning can in some cases significantly reduce the effort required for the measurement, or make further measurements unnecessary.

NOTE 4 This additional information can arise from

- previous measurements of emissions at the identical source of emissions under comparable conditions,
- measurements of emissions at comparable emission sources,
- calculated or estimated mass flow of emissions, e.g. using data from the plant or its operation with the aid of balance sheets for individual substances and
- data related to the process, e.g. knowledge of the relationship between the temperature curve of the process and emissions.

Based on the information collected, the measurement objective shall be reviewed and amended, if necessary.

7.2 Measurement plan

7.2.1 Specification of measurement plan

The measurement plan shall be specified on the basis of the measurement objective (see [7.1](#)).

NOTE Where measurements are being made for regulatory purposes, the customer can need approval of the measurement plan from the competent authority.

In particular the following shall be specified:

- a) operating conditions of the plant including fuel or feedstock, waste gas components and reference quantities to be measured;
- b) timing and siting arrangements of the required individual measurements and measurement dates;
- c) measurement methods to be applied;
- d) measurement sections and measurement sites;
- e) technical supervisor, necessary personnel and auxiliary help for carrying out of the measurements;
- f) reporting arrangements.

7.2.2 Plant operating conditions and load characteristics

The operating conditions of the plant, waste gas composition and reference quantities to be measured shall be specified in accordance with the measurement objective.

The influence of the mode of plant operation, the feed materials, and the waste gas cleaning system in the plant on the emission shall be considered (examples are given in [B.1](#)).

NOTE 1 An essential feature of the specification is the maximum plant output. This determines, for example,

- in the case of combustion plants, the size and shape of the combustion space, the number of burners or number of transporters for combustible matter and the amount of combustible matter which can be fed and
- in the case of production plants, the amount of feed materials which can be used in combination with auxiliaries, additives and the maximum amount of energy required in the form of fuels or electrical energy.

If emission measurements are performed at the highest emission state, this state is established usually at the maximum plant output. However, this relationship does not apply to all measured components. The type and composition of the feed materials shall also be taken into account with respect to the expected emissions. Depending on the plant, the individual emission behaviours can also proceed in opposite directions, for example in the case of combustion plants, the components carbon monoxide and nitrogen monoxide are observed to behave in opposite ways depending on combustion conditions.

NOTE 2 The highest emission state is characterized by the highest emission mass flow. The maximum emission concentration does not inevitably occur at the highest emission mass flow. The measurement objective can refer either to concentration or to mass flow or both.

NOTE 3 To determine the highest emission state it is advisable to make use of the following:

- knowledge from the literature (e.g emission factors);
- specialist discussion with the plant operator and if necessary with the inspection authorities and a plant visit;
- knowledge of the plant type and the associated emission behaviour on the basis of measurements which have already been made on the plant in question or on comparable plants.

7.2.3 Number of individual measurements

The number of individual measurements shall be specified in accordance with the measurement objective.

NOTE When measuring a stable emission best practice is to make a minimum of three measurements. In the case of unstable emissions, the number of samples can be increased to meet the measurement objective. In the case of compliance monitoring for regulatory purposes, the number of individual measurements can be specified in the permit. Examples of regulatory requirements are given in the *Reference Document on the General Principles of Monitoring*^[3].

7.2.4 Timing and duration of individual measurements

The timing and duration of the emission measurement shall be specified in the measurement plan in accordance with the measurement objective.

Where specified, the sampling duration for individual measurements prescribed by legislation (see e.g.^{[6],[7]}), administrative provisions or other official regulations shall be used for emission measurements.

For manual methods, where low concentrations of the measured component are suspected, maximum permissible sampling duration as specified in method of measurement should be used in the first instance to meet the requirement for the field blank.

Sampling timing and duration shall be appropriate for the emission behaviour of the plant considered. A distinction should be made between the following cases:

- continuous processes (constant in time);
- continuous processes with influences varying over time;
- batch processes.

Typical examples of suitable timing and sampling duration for various process types are given in [B.1](#).

7.2.5 Measurement points

Emission measurements of particulate pollutants shall be performed always as grid measurements (see [8.1](#)).

Measurements of gaseous pollutants may be performed at one representative measurement point or at any measurement point, if the corresponding requirements on the distribution of the measurand specified in [8.3](#) are fulfilled. In all other cases the measurements shall be performed as grid measurements.

NOTE Supplementary information as described in [7.1.2 f\)](#) can provide information on the homogeneity.

7.2.6 Measurement methods

The measurement methods to be applied shall be selected according to the measurement objective. In the case of legally prescribed measurements, standard reference methods (SRM) shall be applied.

If alternative methods are used, CEN/TS 14793 shall be considered.

NOTE Guidance for selection of measurement methods is given in CEN/TS 15675.

If periodic measurements are carried out using automated reference methods, the measuring systems shall be checked in accordance with the requirements of the applicable standard before they are used in the field.

7.2.7 Measurement section and measurement site

Requirements for working platforms, positions of measurement ports, power supply, safety and environmental conditions are specified in [6.2.3](#).

The measurement section and measurement site shall be specified and described in detail in the measurement plan (see example form of an emission measurement plan in [B.3](#)).

In the case that the full requirements of this document cannot be met, the principles and procedures shall be followed as fully as possible and any deviation shall be described in the measurement plan.

In some cases, especially in existing plants, it is impossible to choose the position of measurement section and measurement site freely. In such cases the measurement section and measurement site shall be installed or modified in accordance with local plant conditions.

Measurement planning shall consider plant-specific conditions. A check shall be made as to whether in view of the measurement objective the necessary measuring conditions are satisfied (see [8](#)). Alternative arrangements shall be sought if, due to plant conditions, it is not possible to install an optimum measurement section which complies with the requirements of this document. From the alternative arrangements, the best possible measurement section for the measurements under the given circumstances and the best possible measurement site shall be selected and installed.

NOTE In special cases it can be necessary

- a) to measure the total volumetric flow rate (full stream measurement) for measuring the volumetric flow e.g. in small diameter ducts,
- b) to measure the mass concentration and determine the volumetric flow rate by calculation, or
- c) to calculate the mass concentration, for example from the vapour pressure, and to measure the volumetric flow rate.

7.2.8 Technical supervisor and necessary personnel

Appropriate personnel shall be used to carry out the measurement programme.

NOTE Detailed requirements for personnel carrying out emission measurements are given in CEN/TS 15675.

The following key personnel shall be nominated at the start of the measurement from a list of competent personnel in the measurement plan:

- a) personnel responsible for carrying out the measurement;
- b) person technically responsible (technical supervisor);
- c) personnel nominated by the plant to be responsible for the plant operation during the measurement.

The sampling times selected for the measurement plan should be co-ordinated with the shift patterns of the plant personnel. The responsible plant personnel should be available when sampling takes place.

7.2.9 Planning of the measurement dates

Measurement dates shall be specified in the measurement plan. The dates shall be selected to ensure that

- a) the measurement objective is met,
- b) suitable process conditions are available (i.e. condition of the plant and waste gas cleaning facility),
- c) the infrastructure for measurement is in place and operational,
- d) the measuring and analytical systems are available and
- e) the personnel and assistants are available.

7.2.10 Preparation of the measurement

7.2.10.1 Preparations by the plant operator

The measurement plan shall be communicated in accordance with the measurement objective and to relevant parties involved in the measurement process.

The following preparations for measurements shall be performed by the plant operator:

- specified operating conditions (combustion materials/raw materials/load) shall be realized during the time of measurement;
- if not already available, provision of the measuring sites complying with the requirements of [6.2](#);
- covers of the measurement ports shall be lubricated to facilitate easy removal by the testing laboratory; any extraneous matter that has accumulated in or around the measurement port shall be removed;

NOTE 1 Auxiliary staff can be needed for the period of the measurement campaign to assist the personnel performing the measurements.

NOTE 2 Changing room(s) and, if required, a work room can be provided.

NOTE 3 In certain countries legislation can require that measurement sites be inspected by a competent person to determine that the structural integrity of the measurement site is suitable for the work planned.

7.2.10.2 Preparations by the testing laboratory

The following preparations for measurements shall be performed by the testing laboratory:

- necessary personnel for the period of measurement campaign shall be provided;
- necessary measurement equipment for the period of measurement campaign shall be provided in accordance with the requirements of the individual measurement standards that are to be applied;