



BSI Standards Publication

Stationary source emissions - Mercury monitoring using sorbent traps

National foreword

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English Version

Stationary source emissions - Mercury monitoring using sorbent traps

Émissions de sources fixes - Surveillance du mercure à l'aide de pièges adsorbants

Emissionen aus stationären Quellen - Quecksilbermonitoring mit Sorptionsfallen

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European foreword

This document (CEN/TS 17286:2019) has been prepared by Technical Committee CEN/TC 264 “Air quality”, the secretariat of which is held by DIN.

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1 Scope

The purpose of this document is to establish performance benchmarks for, and to evaluate the acceptability of, sorbent trap monitoring systems used to monitor total vapour- phase mercury (Hg) emissions in stationary source flue gas streams. These monitoring systems involve continuous repetitive in-flue sampling using paired sorbent traps with subsequent analysis of the time-integrated samples.

This document is suitable for both short-term (periodic) measurements and long-term (continuous) monitoring using sorbent traps.

NOTE When this Technical Specification has been validated, the sorbent trap method will be an Alternative Method subject to the restrictions on applicability defined below. Until that time, EN 13211 is the only accepted Reference Method for both short-term (periodic) measurements and for calibrating continuous monitoring systems, including those with long-term sampling systems. EN 13211 is a wet chemistry approach that relies on absorption of mercury into impinger solutions.

The substance measured according to this specification is the total vapour phase mercury in the flue gas, which represents the sum of the elemental mercury (Hg^0) and gaseous forms of oxidized mercury (Hg^{2+}), such as mercury (II) chloride, in mass concentration units of micrograms (μg) per dry meter cubed (m^3). The analytical range is typically 0,1 to greater than 50 $\mu\text{g}/\text{m}^3$.

The sorbent tube approach is intended for use under relatively low particulate conditions (typically less than 100 mg/m^3) when monitoring downstream of all pollution control devices, e.g. at coal fired power plants and cement plants. In this case, the contribution of mercury in the particulate fraction is considered to be negligible (typically less than 5 % of total mercury). However, it shall be noted that the sorbent trap does take account of the finest particle fraction that is sampled with the flue gas, in addition to capturing the vapour phase mercury.

This specification also contains routine procedures and specifications that are designed to evaluate the ongoing performance of an installed sorbent trap monitoring system. The operator of the industrial installation is responsible for the correct calibration, maintenance and operation of this long-term sampling system. Additional requirements for calibration and quality assurance of the long-term sampling system are then defined in EN 14884 and EN 14181.

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 14181, *Stationary source emissions — Quality assurance of automated measuring systems*

EN 14790 (series), *Stationary source emissions — Determination of the water vapour in ducts — Standard reference method*

EN 15259:2007, *Air quality — Measurement of stationary source emissions — Requirements for measurement sections and sites and for the measurement objective, plan and report*

EN 15267 (series), *Air quality — Certification of automated measuring systems*

EN 15853, *Ambient air quality — Standard method for the determination of mercury deposition*

EN ISO 16911-1:2013, *Stationary source emissions — Manual and automatic determination of velocity and volume flow rate in ducts — Part 1: Manual reference method (ISO 16911-1:2013)*

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

mercury

mercury and mercury compounds

3.2

total mercury

sum of the mercury in the exhaust gas independent from the state (gaseous, dissolved in droplets, solid, adsorbed or absorbed on and within particles)

3.3

sorbent trap

tube filled with a collection material on which gaseous mercury is collected

3.4

sorbent trap spiking

technique(s) used to spike mercury onto sorbent traps prior to sampling

3.5

sample probe

part of the apparatus that is placed in the flue for the purpose of sampling the gas and measuring the temperature

3.6

moisture removal device

part of the apparatus that is placed before the sample flow measuring device for the purpose of removing water vapour from the sampled gas stream

3.7

gas flow meter

device of any type that allows the total dry sample gas volume to be determined, e.g., a volumetric flow meter or a mass flow meter

4 Symbols and abbreviations

AFR	ratio of dry combustion air to fuel (m^3/kg)
AFR_s	ratio of dry combustion air to fuel at stoichiometric conditions (m^3/kg)
B_w	flue gas moisture content by volume (m^3/m^3)
B_{wa}	concentration of water vapour in ambient air by volume (m^3/m^3)
B_{ws}	concentration of water vapour in stoichiometric flue gas by volume (m^3/m^3)
$\%B$	percent breakthrough
C	concentration of mercury in the dry flue gas for the sample collection period ($\mu g/m^3$)
C_a	concentration of mercury in the dry flue gas for the sample collection period, for sorbent trap "a" ($\mu g/m^3$)
C_b	concentration of mercury in the dry flue gas for the sample collection period, for sorbent trap "b" ($\mu g/m^3$)
C_{est}	estimated mercury concentration in flue gas ($\mu g/m^3$)
C_{rec}	the concentration of spiked compound measured ($\mu g/m^3$)
CFR_s	ratio of dry flue gas to fuel at stoichiometric conditions (m^3/kg)
F_d	dry flue gas volume emitted during the sampling period (m^3)
F_w	wet flue gas volume emitted during the sampling period (m^3)
F_h	average sample flow rate for the hour, in appropriate units (e.g. L/min, mL/min, m^3/min)
F_{ref}	average sample flow rate for first hour of the collection period, in appropriate units (e.g. L/min, mL/min, m^3/min)
Hg^0	elemental mercury
Hg^{2+}	oxidized mercury
K	power of ten multiplier, to keep the value of R_{ref} between 1 and 100. The appropriate K value will depend on the selected units of measurement for the sample flow rate and the range of expected flue gas flow rates
m_s	the total mass of mercury measured on the spiked trap in the FRT (μg)
M_{exp}	expected sample mass (μg)
M_{spiked}	calculated mercury mass of the pre-sampling spike, from 8.2 of this Technical Specification, (μg)
m_{spiked}	the total mass of mercury spiked prior to the FRT (μg)
m_u	the total mass of mercury measured on the unspiked trap in the FRT (μg)
M^*	total mass of mercury recovered from sections 1 and 2 of the sorbent trap, (μg)
M_1	mass of mercury recovered from section 1 of the sorbent trap, (μg)
M_2	mass of mercury recovered from section 2 of the sorbent trap, (μg)
M_3	mass of mercury recovered from section 3 of the sorbent trap, (μg)
O_{2a}	concentration of oxygen in ambient air by volume (m^3/m^3)
$O_{2,wet}$	concentration of oxygen in flue gas by volume, on a wet basis (m^3/m^3)

$O_{2,dry}$	concentration of oxygen in flue gas by volume, on a dry basis (m^3/m^3)
P_a	absolute pressure of ambient air (mbar)
P_T	absolute pressure of saturated flue gas (Pa)
P_v	vapour pressure of water (Pa)
Q_h	average flue gas volumetric flow rate for the hour (m^3/h)
Q_{ref}	average flue gas volumetric flow rate for first hour of collection period at reference conditions (m^3/h)
Q_s	the sample flow rate (L/min)
R	the percentage of spiked mass recovered from the FRT (%)
RD	relative deviation between the mercury concentrations from traps “a” and “b” (%)
R_h	ratio of hourly flue gas flow rate to hourly sample flow rate
RH	relative humidity (-)
R_{ref}	reference ratio of hourly flue gas flow rate to hourly sample flow rate
$\%R$	percentage recovery of the pre-sampling spike
t	temperature of ambient air ($^{\circ}C$)
t_s	expected monitoring period (min)
T	temperature of saturated flue gas (K)
v_s	the volume of gas sampled through the spiked trap in the FRT at standard conditions (m^3)
v_u	the volume of gas sampled through the un-spiked trap in the FRT at standard conditions (m^3)
V_t	total volume of volume measurement during the collection period (m^3). For the purposes of this Technical Specification, standard temperature and pressure are defined as $0^{\circ}C$ and 101.325 kPa, respectively.
W_{aFR}	ratio of ambient water vapour to fuel (m^3/kg)
W_{iFR}	ratio of injected water vapour to fuel (m^3/kg)
WFR_s	ratio of combustion water vapour to fuel at stoichiometric conditions (m^3/kg)
λ	excess air factor (-)
10^{-3}	conversion factor (m^3/L)
ABT	Analytical Bias Test
CRM	Certified Reference Material
CV AAS	Cold Vapour Atomic Absorption Spectrometry
CV AFS	Cold Vapour Atomic Fluorescence Spectrometry
FRT	Field Recovery Test
LOD	Limit of Detection
QA/QC	Quality Assurance/Quality Control
SRM	Standard Reference Method

5 Principle

Known volumes of flue gas are continuously extracted from a flue or duct through paired, in-flue, pre-spiked three-section sorbent traps at appropriate nominal flow rates. The sorbent traps in the sampling system are periodically exchanged with new ones, prepared for analysis as needed, and analysed by any technique that can meet the analytical performance criteria. Mercury is collected on section 1 of the trap. For quality assurance purposes, section 2 is also analysed to quantify mercury breakthrough from the first section. For quality assurance purposes, the third section of each sorbent trap is spiked with Hg^0 prior to sampling. Following sampling, the third section is analysed separately and a specified minimum percentage of the spike shall be recovered. The paired sampling train is required to determine method precision. An Analytical Bias Test (ABT) is required to demonstrate that the laboratory has the ability to recover and accurately quantify mercury from the chosen sorbent traps

A Field Recovery Test (FRT) is also required when the sorbent trap method is used for regulatory monitoring purposes, either for short-term, periodic, sampling (for each test campaign), or for long-term sampling (prior to initial operation and when the sorbent material is changed). For a limited number of FRTs, the spike is added to the first section of a two or three section trap, noting that only one of the paired traps is spiked on the first section. The average recovery of these spiked samples is then used to verify the performance of the measurement system under field conditions since section 1 is exposed to the full flue gas matrix.

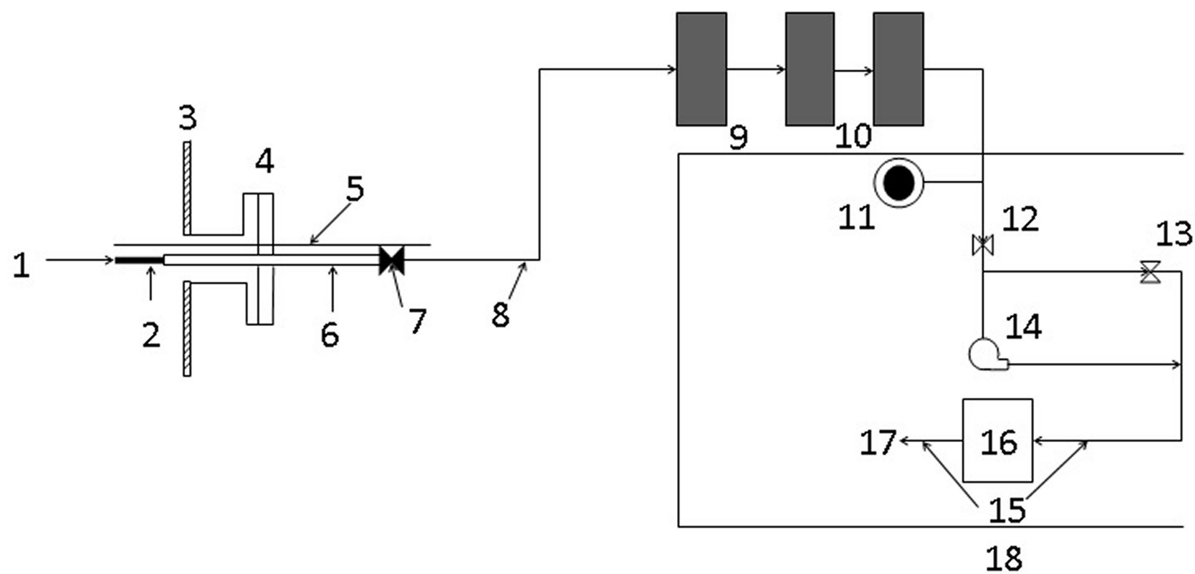
Short-term sampling (for periodic monitoring) is typically from one hour to six hours sampling duration and long-term sampling (for semi-continuous monitoring) is typically from one day to two weeks sampling duration.

6 Measuring equipment

6.1 Sorbent trap monitoring system equipment specifications

6.1.1 Monitoring system

A typical sorbent trap monitoring system is shown in Figure 1.



Key	
1 gas inlet	10 desiccant
2 sorbent trap	11 vacuum gauge
3 duct wall	12 isolation valve
4 port/probe flanges	13 flow control valve
5 temperature sensor	14 gas pump
6 probe	15 alternative locations for temperature and pressure sensors (for volumetric dry gas flow meter)
7 isolation valve	16 dry gas flow meter
8 sample line	17 discharge
9 water knockout	18 sampling console

Figure 1 — Sorbent trap monitoring system (only one trap and associated sampling system is shown)



Key	
S1 MAIN: Standard collection section	P1 entry plug
S2 BACKUP: Break-through detection	P2 separation plug
S3 SPIKE: Pre-Injected mercury vapour (±50 % of expected mass to be collected)	P3 separation plug
	P4 exit plug

Figure 2— Three section sorbent trap

The sorbent used to collect mercury shall be configured in traps with three distinct segments or sections, connected in series, to be separately analysed, as shown schematically in Figure 2. Section 1 is designated for primary capture of gaseous mercury. Section 2 is a backup section for the determination of vapour-phase mercury breakthrough. Section 3 is specified for quality assurance/quality control (QA/QC) purposes. Section 3 shall be spiked with a known amount of gaseous Hg^0 prior to sampling and later analysed to determine the spike (and hence sample) recovery efficiency.

The spike is applied to the first section of the trap for the FRT and the ABT as described in Clause 11. These traps therefore consist of two, rather than three, sections.

Each sorbent trap shall be inscribed or otherwise permanently marked with a unique identification number, for tracking purposes. The sorbent media may be any collection material (e.g. activated carbon, a chemically-treated filter, etc.) capable of quantitatively capturing and recovering, for subsequent analysis, all gaseous forms of mercury in the emissions from the intended application. Selection of the sorbent media shall be based on the material's ability to achieve the performance criteria contained in this Technical Specification, especially the requirement to have a suitably high collection efficiency within the given flue gas matrix. The sorbent traps shall be obtained from a source that can demonstrate their quality assurance and quality control.

The paired sorbent traps are supported on a probe (or probes) and inserted directly into the flue gas stream, noting that the traps may be protected by a shield or baffle to prevent the ingress of droplets when present. Fine particles, associated with the gas sample, are drawn into the trap and are captured either within a pre-filter, or the plug of glass wool that separates each section, or within the sorbent itself. Mercury extracted from pre-filter(s) and plugs upstream of Section 1 is added to the Section 1 result. Mercury extracted from plugs immediately upstream and downstream of Section 2 are added to the Section 2 result. Mercury extracted from plugs downstream of Section 3 are added to the Section 3 result.

Further information on typical sorbent trap configurations is given in Annex D.

6.1.2 Moisture removal device

A moisture removal device or system shall be used to remove water vapour from the gas stream prior to entering the dry gas flow metering devices.

6.1.3 Vacuum pump

Use a leak-tight, vacuum pump capable of operating within the system's flow range. If the vacuum pump is the last element in the sampling train, located downstream of the sample to gas flow meter measurement device, it does not need to be leak-tight.

6.1.4 Total sample volume measurement

A dry gas flow meter (e.g. a volumetric flow meter, thermal mass flow meter, or other suitable measurement device) shall be used to determine the total sample volume on a dry basis, in units of standard cubic meters. The gas flow meter, with a maximum expanded uncertainty of 5,0 % at the anticipated flow rate, incorporating any associated uncertainties including the absolute pressure and absolute temperature measurement uncertainties (maximum expanded uncertainty of 2,0 % each), shall be calibrated at selected flow rates across the range of sample flow rates at which the sampling train will be operated, typically 0 to 2 L/min.

6.1.5 Sample flow rate meter and controller

Use an automated flow rate indicator and controller for maintaining the required sampling flow rate. Any additional standard uncertainty associated with a separate display device shall be less than 0,5 %.

NOTE Manual flow control and data recording can be employed for short-term sampling.

6.1.6 Temperature sensor

Temperature sensor with a standard uncertainty of less than 2,5 K (less than 1 % relative to the absolute temperature).

6.1.7 Absolute pressure sensor

Absolute pressure sensor with a standard uncertainty of less than 1 kPa (10 mbar) (less than 1 % relative to the absolute pressure).

6.1.8 Automatic controller

An automatic controller when employed for either long-term or short-term sampling shall have the following automatic functions:

- a) maintenance of the volume proportional sampling condition;
- b) leak test at the start and end of the sampling period (or this can be performed manually as an option);
- c) restart after power loss (after start-up procedures are completed);
- d) automatic start and stop of sampling to capture normal operation of the plant; this is achieved using external control signals that define start-up and shut-down, e.g. plant output load or flue gas oxygen content (a manual over-ride shall be provided in case of malfunction of the automated system).

The console for an automated sampling system used for long-term sampling shall be password protected to prevent unauthorised access.

6.1.9 Sample preparation

Remove the end cap of a sorbent trap. Carefully separate the three sections (P1 + S1; P2 + S2; P3 + S3) of each trap. The materials (plug and sorbent) associated with each section shall be analysed jointly or individually. The exit plug P4 is discarded. If the sorbent mass is large enough (usually > 1,0 g), it can be mixed well, split into 2 parts, and analysed. If traps are equipped with an acid gas scrubber (see ANNEX D) or any other auxiliary section, these sections are analysed separately from the sorbent sections. The mercury adsorbed on them is reported separately.

6.1.10 Sample analysis equipment

Any analytical system capable of quantitatively recovering and quantifying total gaseous mercury from sorbent traps is acceptable provided that the analysis can meet the performance criteria in Table 2 in Clause 9 of this Technical Specification. Candidate recovery techniques include leaching, digestion and thermal desorption. Candidate analytical techniques include but are not limited to: cold vapour atomic fluorescence spectrometry (CV AFS) and cold vapour atomic absorption spectrometry (CV AAS) with and without gold amalgamation. Thermal decomposition with wet chemical trapping or direct introduction into an atomic spectrometry detection system, with or without catalytic pre-treatment and amalgamation, are also commonly used approaches.

6.1.11 Sorbent trap spiking system

A known mass of gaseous Hg^0 shall be spiked onto section 3 of each sorbent trap prior to sampling. Any approach capable of quantitatively delivering known masses of Hg^0 onto sorbent traps is acceptable. Several technologies or devices are available to meet this objective. Their practicality is a function of mercury mass spike levels. For low levels, SI traceable and certified gas generators or tanks may be suitable but will likely require long preparation times.

A more practical, alternative system, capable of delivering almost any mass required, employs SI traceable and certified mercury salt solutions (e.g. $\text{Hg}(\text{NO}_3)_2$). With this system, an aliquot of known volume and concentration is added to a reaction vessel containing a reducing agent (e.g. stannous

chloride); the mercury salt solution is reduced to Hg^0 and purged onto section 3 of the sorbent trap by using an impinger sparging system.

NOTE The spike is applied to the first section of the trap for the FRT and ABT as described in Clause 11.

Further details are given in Annex A.

7 Reagents and standards

Only certified or traceable calibration gas standards and high purity reagents shall be used for the tests and procedures required under this Technical Specification. The sorbent traps may be any collection material (e.g. activated carbon or a chemically treated filter) capable of quantitatively capturing and recovering, for subsequent analysis, all gaseous forms of mercury in the emissions from the intended application. Selection of the sorbent traps shall be based on the ability of the sorbent material to achieve the performance criteria contained in this Technical Specification as well as the vapour phase mercury capture efficiency of the sorbent for the emissions matrix and the expected sampling duration at the test site.

8 Performance specification test procedure

8.1 Selection of monitoring site and initial sampling conditions

Sampling may be carried out at a single point in the duct if it is demonstrated that gaseous mercury is homogeneously distributed in the duct, according to the requirements of EN 15259:2007.

EN 15259:2007 recognizes that a surrogate parameter may be used for the test of homogeneity. Typically, oxygen is used but under some circumstances, such as after a wet scrubber abatement system, sulphur dioxide is a more appropriate surrogate.

The sampling point shall preferably be located near the middle of the duct but at least 0,1 D away from the wall.

When the sampling is carried out under these conditions, this choice shall be justified in the test report, and supported by the results of preliminary homogeneity test measurements.

An estimation of the expected flue mercury concentration is required to establish a target sample flow rate, total gas sample volume and the mass of Hg^0 to be spiked onto each sorbent trap.

8.2 Pre-sampling spiking of sorbent traps

Based on the estimated mercury concentration in the flue, the target sample rate and the target sampling duration, calculate the expected mass loading, to be extracted from the flue gas, for section 1 of each sorbent trap (see 12.1 of this Technical Specification). The pre-sampling spike to be added to section 3 of each sorbent trap shall be within $\pm 50\%$ of the expected section 1 mass loading. Spike section 3 of each sorbent trap at this level, as described in 6.1.11 of this Technical Specification. For each sorbent trap, keep a record of the mass of Hg^0 added to section 3. This record shall include, as a minimum, the identification number of the trap, the date and time of the spike, the name of the analyst performing the procedure, the method of spiking, the mass of Hg^0 added to section 3 of the trap (μg) and the supporting calculations.

NOTE The spike is applied to the first section of the trap for the FRT and ABT as described in Clause 11.

8.3 Field blanks

A field blank shall be taken at each measurement site either before or after each measurement series, in the case of short-term sampling and at least twice per year for long-term sampling:

- a) assemble the equipment (following the usual assembly procedure at the normal location);

- b) perform a leak check;
- c) disassemble the equipment.

This leads to an estimation of the scatter of results for a near zero concentration, i.e. contamination of tubes during handling on site, transport, storage and handling in the laboratory.

The field blank value shall be calculated using the field blank mass divided by the average sample volume of the measurement series.

All field blank values shall be reported individually. The field blank value shall not exceed 10 % of the expected test mass loading (divided by the average sample volume) or $0,1 \mu\text{g}/\text{m}^3$, whichever is greater. Test results that are less than the field blank value shall be reported as less than or equal to the field blank value.

Field blank tubes comprise conditioned sorbent tubes, taken from the same batch as those used for field monitoring, opened and handled in the same manner at the sample location as the sampling tubes but without putting them in the flue or pulling the flue gas through them. They are subsequently analysed with the sampled tubes to determine the average blank level of mercury.

8.4 Pre-monitoring leak check

Perform a leak check with the sealed (capped) sorbent traps in place in the sampling system. Draw a vacuum in each sample train. Adjust the vacuum in each sample train to ~ 500 mbar. The pre-monitoring leak check shall be controlled to a level below 5 % of the sampling rate. The leak test shall cover the assembly of all components of the sampling equipment, from the probe to the sample flow meter. Once the leak check passes this criterion, carefully release the vacuum in the sample train, downstream of the traps, in order to avoid contamination of the sorbent traps.

8.5 Determination of flue gas characteristics

Determine or measure the flue gas characteristics (gas temperature, static pressure, gas velocity, moisture content, dust concentration etc.) in order to determine ancillary requirements such as probe heating requirements (if any), sampling rate, proportional sampling conditions, moisture management, etcetera.

8.6 Monitoring

8.6.1 System preparation and initial data recording

Remove the cap from the end of each sorbent trap and store each cap in a clean sorbent trap storage container. Remove the flue or duct port cap and insert the probe(s) with the inlet(s) aligned perpendicular to the flue gas flow. Secure the probe(s) and ensure that no leakage occurs between the duct and the surrounding environment. Record initial data including the sorbent trap ID, start time, starting gas flow meter readings, initial temperatures, set points, and any other appropriate information. More detailed requirements are described in ANNEX E.

8.6.2 Flow rate control

Set the initial sample flow rate at the target value from 12.2 of this Technical Specification. Then, at least every thirty minutes (for long-term sampling) or at least every 5 min (for short-term sampling), record the date and time, the sample flow rate, the sample volume, the flue gas temperature, the volume flow meter temperature and pressure (if applicable), temperatures of heated equipment such as the vacuum lines and the probes (if heated), and the sampling system vacuum readings. More detailed requirements are described in Annex E.

For long-term sampling systems, also record the flue gas flow rate and the ratio of the flue gas flow rate to the sample flow rate. Adjust the sampling flow rate to maintain proportional sampling, i.e. keep the

ratio of the flue gas flow rate to sample flow rate within $\pm 25\%$ of the reference ratio (see 12.2 of this Technical Specification). The sample flow rate through a sorbent trap monitoring system shall be zero when the process is considered to be not operating for compliance purposes.

For short-term sampling, adjust the sample flow rate as necessary to maintain the initial sample flow rate and ensure that the total volume sampled for each test is within 20 % of the total volume sampled for the FRT.

8.6.3 Flue gas moisture determination

The mercury concentration of the flue gas is determined on a dry basis. Mass emissions of mercury can therefore be calculated by multiplying the measured dry mercury concentration by the volume of dry flue gas emitted from the plants during the sampling period.

When the flue gas volume flow rate is calculated on a dry basis according to EN ISO 16911-1:2013, Annex E, i.e. from the thermal input of the plant, then the flue gas moisture content is evidently not required for the mass emissions determination. However, the flue gas moisture content may still be useful for improving the accuracy of the proportional sampling approach, as described in 12.2.

When the flue gas volume flow rate is measured on a wet basis, the moisture content of the flue gas is required in order to correct the flue gas flow rate to a dry basis. If the moisture is measured continuously by the plant then this measurement shall be used provided that the moisture monitor has been calibrated according to EN 14181. Otherwise, for short-term, periodic mercury monitoring, the moisture in the flue gas shall be measured according to EN 14790 and, for long-term (continuous) monitoring, a calculated moisture content may be used by agreement with the Competent Authority, noting that EN 14181 specifically allows this for plants with wet abatement systems. The moisture calculation approach may be specified by the Competent Authority or it may be calculated according to Annex B of this Technical Specification.

The moisture content is used to correct the measured wet flue gas volume to give the dry flue gas volume emitted during the sampling period, as follows:

$$F_d = F_w \cdot (1 - B_w) \quad (1)$$

where

F_d is the dry flue gas volume (m^3);

F_w is the wet flue gas volume (m^3);

B_w is the flue gas moisture content by volume.

NOTE B_w is the proportion of water vapour in the flue gas expressed as a decimal number less than unity.

8.6.4 Essential operating data

Obtain and record any essential required operating data during the test period, e.g. temperatures, pressures, flow rates and flue gas composition. At the end of the data collection period, record the total sample gas volume and the final values of all other essential parameters.

8.6.5 Post-monitoring leak check

When the monitoring period is completed, turn off the sample pump, remove the probe/sorbent trap from the port and carefully re-cap the inlet of each sorbent trap. Perform a leak check with the sorbent traps in place, at the maximum vacuum reached during the monitoring period. Use the same general approach described in 8.4 of this Technical Specification. Record the leakage rate and vacuum. The leakage rate shall not exceed 5 % of the average sampling rate for the monitoring period. Once the leak check passes this criterion, carefully release the vacuum in the sample train, downstream of the traps in

order to avoid contamination of the sorbent traps. The leak test shall cover the assembly of all compounds of the sampling equipment, from the probe to the sample flow meter.

8.6.6 Sample recovery

Recover each sampled sorbent trap by removing it from the probe and seal both ends. Wipe any deposited material from the outside of the sorbent trap. Place the sorbent trap into an appropriate sample storage container and store/preserve it in an appropriate manner.

8.6.7 Sample handling, storage, and transport

While the performance criteria of this approach provide for verification of appropriate sample handling, it is still important that the user considers, determines, and plans for suitable sample handling, storage, transport and holding times for these measurements which may depend on the sorbent traps used. Manufacturers' instructions shall be followed, noting that in all circumstances, the outside of the sorbent traps shall be wiped off once these have been sealed post-sampling.

8.6.8 Sample custody

Proper procedures and documentation for sample chain of custody are critical to ensuring data integrity.

9 Quality assurance/quality control (QA/QC)

Table 1 and Table 2 summarize the QA/QC performance criteria that are used to validate the mercury emissions data from a sorbent trap system. Failure to achieve these performance criteria will result in invalidation of mercury emissions data, except where otherwise noted.

Table 1 — QA/QC criteria for all sorbent trap measurements

QA/QC test or specification	Acceptance criteria	Frequency	Consequences if not met
Pre-monitoring leak check	≤ 5 % of target sampling rate	Prior to monitoring	Monitoring shall not commence until the leak check is passed.
Post-monitoring leak check	≤ 5 % of average sampling rate	After monitoring	Invalidate the data from the paired traps or, if certain conditions are met, report adjusted data from a single trap (see Clause 12).
Ratio of flue gas flow rate to sample flow rate (long-term sampling)	Hourly ratio may not deviate from the reference ratio by more than ± 25 %. NOTE: Plants that comply based on half-hourly averages shall apply a 30 min criterion	Every hour throughout long-term sampling period (minimum requirement)	
Gas flow meter calibration (short-term sampling)	An initial calibration factor (Y) shall be determined at three settings. An annual three point re-calibration is required. For optional single point	Annual recalibration is required with optional audits at the user's discretion	Traceable re-calibration of the meter at three settings to determine a new value of Y.