Editorial note: This document is an unofficial reading version. Only the officially announced version of the Federal Uniform Practice in the Monitoring of Emissions, published on 14 September 2023 in the Joint Ministerial Journal Issue 43/2023, is legally binding:

Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

Federal uniform practice in the monitoring of emissions[1]

- Circular of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection of 31.7.2023 – AG C I 2 – 5025/001-2023.0001 —

Guidelines concerning:

- the suitability test of measuring or data acquisition and evaluation devices for continuous emission measurements and the continuous acquisition of reference or operating variables and for the continuous monitoring of the emissions of specific substances
- Suitability testing and use of portable automatic measuring devices
- the use, installation, calibration and maintenance of continuously operating measuring and data collection and evaluation devices
- the evaluation of continuous emission measurements

The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection and the state authorities responsible for immission protection have reached agreement on the following guidelines in the Federal/state working group for Immission Protection.

Distribution:

To the immission protection authorities of the federal states

---

1 Notified in accordance with Directive (EU) 2015/1535 of the European Parliament and of the Council of 9 September 2015 laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services (OJ L 241, 17.9.2015, p. 1). Notification number: 2023/200/D.

TABLE OF CONTENTS

ANNEX

1. Introduction

The following guidelines concern the monitoring of emissions with automatic measuring devices and the parameters relevant to the monitoring of emissions; they include the evaluation of continuous emission measurements and the remote transmission of emission-relevant data.

1.1 Legal basis

The Thirteenth Ordinance for the Implementation of the Federal Immission Control Act (Ordinance on Large Combustion, Gas Turbine and Internal Combustion Engine Systems - 13th Federal Immission Protection Decree of the BMUV of 6 July 2021 (Federal Law Gazette I p. 2514) stipulates that the systems mentioned there must be equipped with measuring devices for the continuous determination of emissions and that the measurement results must be continuously registered, automatically evaluated and, if necessary, telemetrically transmitted.

The Seventeenth Ordinance for the Implementation of the Federal Immission Control Act (Ordinance on the incineration and co-incineration of waste - 17th Federal Immission Protection Decree of the BMUV) of 2 May 2013 (Federal Law Gazette I p. 1021, 1044, 3754), last amended by Article 2 of the Ordinance of 6 July 2021 (Federal Law Gazette I p. 2514), stipulates that systems shall be equipped with devices for continuous determination, evaluation and assessment of the emissions as well as equipment for assessing the operating variables required for proper operation. Furthermore, it is prescribed that the measurement results must be continuously registered, automatically evaluated and, if necessary, transmitted telemetrically.

For installations requiring authorisation that do not comply with the provisions of the 13th Federal Immission Protection Decree or the 17th Federal Immission Protection Decree, the conditions are laid down under which the significant emissions of dust and gaseous air pollution shall be continuously monitored and the measurement results continuously registered and automatically evaluated and, if necessary, telemetrically transmitted in order to implement § 29 in conjunction with § 48 (1) number 3 of the law for the protection against harmful environmental

effects through air pollution, noise, vibrations and similar processes (Federal Immission Control Act - BImSchG) in the version of the announcement of 17 May 2013 (Federal Law Gazette I p. 1274; 2021 I p. 123), last amended by Article 2 (3) of the law of 19 October 2022 (Federal Law Gazette I p. 1792) in the First General Administrative Regulation on the Federal Immission Protection Decree (Technical Instructions for Air Pollution Control - TA Luft) of 18 August 2021 (Joint ministerial Gazette 2021, p. 1050 no. 48-54 of 14 September 2021).

According to number 5.3.4 of TA Luft, it should be required for systems with emissions of substances according to number 5.2.2, number 5.2.5 class I or number 5.2.7 that the mass concentration of these substances in the exhaust gas as a daily mean value, based on the daily operating time, is determined when ten times the mass flows specified there are exceeded and no specifications for continuous monitoring are made in number 5.3.3.2. The 17th Federal Immission Control Ordinance stipulates in § 20 (special monitoring of emissions of heavy metals) comparable requirements of measurement technology to TA Luft for the measurement to determine the substances according to Annex 1 (emission limit values for heavy metals and carcinogenic substances), but with different criteria for sampling time and frequency of individual measurements (long-term sampling).

The Twenty-Seventh Ordinance for the implementation of the Federal Immission Control Act (ordinance on cremation facilities - 27th Federal Immission Control Ordinance) of 19 March 1997 (Federal Law Gazette I p. 545), last amended by Article 10 of the ordinance of 2 May 2013 (Federal Law Gazette I p. 973) stipulates that cremation facilities must be equipped with devices that continuously register the mass concentration of carbon monoxide in the exhaust gas, the reference values required for the evaluation and assessment of the emission measurements, the operating parameters required to assess and evaluate automatically the proper operation and functionality of the dust separation device.

The Thirtieth Ordinance for the Implementation of the Federal Immission Control Act (ordinance on plants for the biological treatment of waste - 30th Federal Immission Control Ordinance) of 20 February 2001 (Federal Law Gazette I p. 305, 317), last amended by Article 1 of the ordinance of 12 October 2022 (Federal Law Gazette I, p. 1800), requires that suitable measuring devices must be used to

determine, register and evaluate the emissions and the required operating parameters.

The Thirty-First Ordinance implementing the Federal Immission Protection Act (Ordinance on limiting the emissions of volatile organic compounds when organic solvents are used in certain installations — 31st Federal Immission Control Ordinance) of 21 August 2001 (Federal Law Gazette I p. 2180), last amended by Article 13 of the law of 27 July 2021 (Federal Law Gazette I p. 3146), requires that systems that do not require a permit if the mass flow of total carbon exceeds 10 kilograms per hour must be equipped with a suitable measuring device that continuously determines the total carbon content and the operating parameters required for the evaluation and assessment of the measurement results.

The Forty-Fourth Ordinance for the Implementation of the Federal Immission Control Act (Ordinance on medium-sized combustion gas turbine and combustion engine systems - 44. Federal Immission Control Ordinance) of 13 June 2019 (Federal Law Gazette I p.804), last amended by Article 1 of the ordinance of 12 October 2022 (Federal Law Gazette I, p. 1801), requires that certain systems be equipped with suitable measuring and evaluation devices that continuously determine, register and evaluate emissions or operating variables.

For all the above tasks, the use of appropriate measuring and evaluation devices is required. The appropriate measuring and evaluation facilities are published in the Federal Gazette.

For the determination of the annual emission of a plant within the scope of the law on trading in allowances for the emission of greenhouse gases (Greenhouse Gas Emissions Trading Act - TEHG) of 21 July 2011 (Federal Law Gazette I p. 1475), last amended by Article 18 of the law of 10 August 2021 (Federal Law Gazette I p. 3436), and reporting according to § 5 TEHG, measuring and evaluation devices can be used for continuous emission measurement that meet the requirements of Articles 41 to 45 of Regulation (EU) 2018/2066 of 19 December 2018 (Monitoring Ordinance - MVO, OJ No. L 334, p.1), last amended by Commission Regulation (EU) 2022/388 of 9 March 2022 (OJ No. L 79 p .1) for all relevant parameters (mass concentration of greenhouse gases and exhaust gas volume flow). In order to ensure a nationwide evaluation of greenhouse gas emissions determined with

continuous emission measuring devices, evaluation devices that have been tested for suitability should be used for the scope of emissions trading.

1.2 Scope of application

The following guidelines deal with

- the minimum requirements that have to be made during the suitability test for automatic measuring devices for determining emissions and reference values, for data acquisition and evaluation devices and systems for remote emission data transmission
- the specific requirements for long-term sampling systems
- the testing institutes eligible for the suitability test
- the procedure for the publication and certification of appropriate measuring devices
- Instructions for the installation, calibration, functional testing, use and maintenance of measuring devices for continuous emission measurements, data acquisition and evaluation devices and systems for long-distance emission data transmission as well as checking combustion conditions
- Notes on the use of portable automatic measuring devices for recurring measurements

1.3 Repeal of directives

The following guidelines replace the following regulations:

- Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMUB) circular of 23/1/2017 — Ref.: IG I 2 - 45053/5 (Joint Ministerial Gazette 2017, pp. 234-272)

2. Minimum requirements for the suitability test

2.1 Common requirements for measuring and data collection and evaluation devices for continuous determination of emissions and reference values

2.1.1 For the suitability test, the guidelines DIN EN 15267-1 (issue July 2009) and DIN EN 15267-2 (issue July 2009) must be observed. In addition, the following requirements shall be met.

2.1.2 The suitability test shall include the complete measurement or data collection and evaluation device, including sampling, sample preparation and data output. The manufacturer's operating instructions as part of the measuring or data acquisition and evaluation device must be included in the suitability test and attached to the test report. Both the operating instructions and other documents relating to the measuring device or data acquisition and evaluation device that are intended for publication (e.g. test reports/notifications) must be in German. For other documents (e.g. audit reports), the template may also be in English.

2.1.3 The suitability test report must be publicly available on the website qal1.de.

2.2 Additional requirements for automatic measuring equipment for continuous determination of emissions and reference values

2.2.1 **Common requirements for measuring equipment for continuous determination of emissions and benchmarks**

2.2.1.1 The suitability test for measuring equipment for continuous monitoring of emissions and reference values is to be carried out in compliance with the minimum requirements and test procedures of DIN EN 15267-3 (edition March 2008) and the VDI 4203 sheet 1 (issue September 2017). For certain measuring devices, special requirements may have to be observed for the suitability test.

2.2.1.2 The measuring devices should be designed in such a way that the display range can be adapted to the respective measuring task. As a rule, the display range should be 1.5 times the applicable emission limit values or emission limits for the half-hourly mean value. Further measuring ranges for certain system types are to be included in the suitability test according to Annexes C to I.

2.2.1.3 For measuring equipment for use on installations of the 13th Federal Immission Control Ordinance, a statement shall be made as to whether they meet the availability requirements in accordance with § 19(1) of the 13th Federal Immission Control Ordinance, for use on installations of the 17th Federal Immission Control Ordinance as to whether they meet the availability requirements in accordance with Annex VI, Part 8, point 1.2 of Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control) of 24 November 2010 (OJ EC, L 334, pp. 17-119).

2.2.1.4 If the measuring device has an analogue measurement output, it shall have a 20 mA current loop with live zero point at 4 mA.

The external measurement signal, the status signals and information such as device type, measurement range, measurement variable and unit can also be transmitted via a suitable digital interface from the measurement device to the data acquisition and evaluation device. The individual analogue outputs can then be omitted. The digital interface must fully comply with the VDI guideline series 4201 (VDI 4201 sheet 1, issue September 2010; VDI 4201 Sheet 2, issue July 2014; VDI 4201 Sheet 3, issue July 2012; VDI 4201 Sheet 4, issue July 2012).

2.2.2 **Measuring equipment for monitoring dust separators**

The suitability test should be carried out in compliance with the minimum requirements and testing procedures of DIN EN 15859 (issue August 2010).

2.2.3 **Measuring devices for determining the soot number (exhaust gas opacity)**

The requirements set out in Annex A2 to VDI 4203 Sheet 1 (issue September 2017) must be met.

2.2.4 **Measuring devices for the determination of organic compounds (total carbon content)**

2.2.4.1 For measuring devices that work with flame ionisation detection (FID), the requirements of DIN EN 12619 (issue April 2013) also apply. These requirements apply to the complete measuring device.

2.2.5 **Measuring equipment for the determination of exhaust gas velocity and volume flow**

In addition, in the suitability test, DIN EN ISO 16911-2 (issue June 2013) must be observed.

2.3 Additional requirements for data collection and evaluation devices

2.3.1 **General requirements for data collection and evaluation devices**

2.3.1.1 The suitability test shall be carried out in accordance with the DIN EN 17255 series of standards (DIN EN 17255-1, issue October 2019; DIN EN 17255-2, issue July 2020; DIN EN 17255-3, issue December 2021). In addition, the following requirements shall be met.

Where applicable, the requirements of VDI 4203 Part 1 (issue September 2017) shall apply mutatis mutandis.

2.3.1.2 The data acquisition and evaluation device must carry out the classification as well as the storage and data output according to the Annexes, in particular Annex B, in full.

2.3.1.3 If the data collection and evaluation device is to carry out the emission data analysis for greenhouse gas emissions, the requirements of Sections 8.1.3, 8.2.2, 8.3.2, 8.4.3 and 8.10.3 of VDI 4204 Sheet 1 (issue March 2022) must also be taken into account.

2.3.2 Specific requirements for data collection and evaluation devices

2.3.2.1 For measuring distance testing and for testing the measurement signal inputs for analogue measuring signals (in mA), the connection of a measuring sensor should be possible. This connection option must be secured against unauthorised use during continuous operation.

Analogue measurement inputs should cover the current range from 0 mA to 20 mA. The input resistance for each measurement channel should not exceed around 50 Ω and 100 Ω. If multiple processing of a measured variable is required, it should be possible to connect various channels in series or query via a multiplexer. [to Section 6.2.2.2 of DIN EN 17255-3]

2.3.2.2 If the data acquisition and evaluation device has suitable digital interfaces for data exchange with the automatic measuring devices, these must fully comply with the VDI guideline series 4201 (VDI 4201 Part 1, issue September 2010; VDI 4201 Sheet 2, issue July 2014; VDI 4201 Sheet 3, issue July 2012; VDI 4201 Sheet 4, issue July 2012).

When testing the measurement path transmission using a digital interface, the simulation mode must be used in accordance with VDI 4201 Part 1 (issue September 2010). The data collection and evaluation device shall enable simultaneous and independent simulation of all measurement components.

Note: This is required for the settlement check in the course of the installation certificate or annual computer AST.

This simulation mode or a corresponding internal computer function can be used to check the proper evaluation of all measuring signals. The use of these functions must be protected against unauthorised use. [regarding Section 6.2.2.3 of DIN EN 17255-3]

2.3.2.3 The basic data (FLD) of the AMS are to be formed from the uncounted raw data according to VDI 4204 Part 1 (issue March 2022) Section 7.1. Deviating from this, an averaging over a maximum of 10 s is permissible. [regarding Section 6.3.2 of DIN EN 17255-3 in conjunction with Section 7.2 of DIN EN 17255-1]

2.3.2.4 The status identifier of the FLD is to be derived from the measured variable-related status identifier (letter) and the operating mode (number).

The measured variable-related status identifier is to be formed according to Section 7.1 of VDI 4204 Sheet 1 (issue March 2022) and a status identifier according to Table 4 of the VDI guideline is to be used.

In addition, a status identifier for the operating mode of the system depending on the operating status of the system must be defined for the FLD and determined according to Table 11 of VDI 4204 Sheet 1 (March 2022 edition). The operating mode that has lasted the longest should be selected. If there are operating modes with the same time shares, the operating mode with the highest priority must be used according to the order in the system-specific operating mode table. [to Section 6.3.2 of DIN EN 17255-3 in conjunction with Section 7.4 of DIN EN 17255-1]

Table Table 1 shows an example of the formation of the status identifier of an FLD.

Table 1: Example of formation of the status identifier of an FLD

Status ID	
measurement-related status identifier	Operating mode (BA)
G	1

Note: There is no distinction as to whether the AMS is during a functional control (QAL2 or AST), during an internal test, QAL3 or during other maintenance, since the signal output of the AMS normally does not allow such differentiation.

2.3.2.5 For calculations of sizes from short-term mean values (e.g. sulphur deposition level, emission load) the following applies in principle:

- The averaging period and the standardisation or reference status of the respective short-term mean values shall be identical.

• Short-term mean values that are validated are validated for calculation. Short-term mean values that are not validated are not validated for calculation.

• A mean value calculated from mean values of several measured variables is valid if all the mean values used for the calculation are valid. This does not apply to measured variables for which substitute values have been specified.

[to section 6.4.1 of DIN EN 17255-3]

2.3.2.6 The status identifier for short-term mean values (STA) shall be established in accordance with Section 8.3.1 of the VDI 4204 Sheet 1 (issue March 2022).

In addition, it should be possible to increase the priority of the respective status by reducing the minimum time to ≥ 1/10 for the following cases with valid STA:

- Measured value status 1 not subject to assessment (N)
- Measured value status 2 start-up/shutdown or start-up/shutdown operation (A)
- Measured value status 2 ARE failure (R)

[regarding Section 6.4.1 of DIN EN 17255-3 in conjunction with Section 8.4 of DIN EN 17255-1]

Note: The application of the changed priority of the respective status in the cases mentioned by reducing the minimum time to ≥ 1/10 is at the discretion of the authority.

2.3.2.7 Separate recording of STA containing FLD values outside the measuring range and STA containing capped FLD values is not necessary, since the former only occur with analogue data transmission and the latter only in the case of digital data transmission. [regarding Section 6.4.1 of DIN EN 17255-3 in conjunction with Section 8.4 of DIN EN 17255-1]

2.3.2.8 If at least two-thirds of valid FLDs are available during the averaging period of the STA for plant operation requiring assessment, the mean

value of the STA is to be formed from the valid FLD for plant operation requiring assessment. Otherwise, in the case of plant operation subject to monitoring, invalid STAs that do not require assessment or are to be formed from all valid FLDs in the averaging period. [regarding Section 6.4.1 of DIN EN 17255-3 in conjunction with Section 8.5 of DIN EN 17255-1]

Note: STA are valid if there are valid FLD for at least two thirds of the averaging period for the STA for plant operation requiring assessment.

2.3.2.9 Sections 8.4.1, 8.4.2 and 8.5 of VDI 4204 Part 1 (issue March 2022) must be observed when forming the normalised short-term mean values without oxygen reference value calculation (SSTA) and the normalised short-term mean values with oxygen reference value calculation (OSSTA). [regarding Section 6.4.1 of DIN EN 17255-3 in conjunction with Section 8.7 of DIN EN 17255-1]

2.3.2.10 Sections 8.10.1 and 8.10.2 of VDI 4204 Sheet 1 (issue March 2022) must be observed when forming the short-term values of the emission mass flow for the balancing and the short-term values of the emission mass flow for the limit value comparison. [regarding Section 6.4.1 of DIN EN 17255-3 in conjunction with Section 8.9 of DIN EN 17255-1]

2.3.2.11 For the formation of validated short-term mean values (VSTA), section 8.6 of the VDI 4204 Sheet 1 (issue March 2022) must be observed. [regarding Section 6.4.1 of DIN EN 17255-3 in conjunction with Section 8.11 of DIN EN 17255-1]

2.3.2.12 In addition, when calculating valid daily mean values, there must be the option of specifying a lower coverage of the day by valid short-term mean values, but at least two hours.

Note: Valid short-term mean values which are not taken into account in the formation of the daily mean value due to special regulations in accordance with 4.7.4 are also not taken into account when determining the validity of the daily mean value.

[regarding Section 6.4.1 of DIN EN 17255-3 in conjunction with Section 8.12 of DIN EN 17255-1]

2.3.2.13 The status identifier for long-term mean values (LTA) is to be formed according to Section 8.8 Table 15 of VDI 4204 Sheet 1 (issue March 2022). [regarding Section 6.4.1 of DIN EN 17255-3 in conjunction with Sections 8.12 and 8.15 of DIN EN 17255-1]

Note: In the case of daily averages, a distinction must be made between the validity of daily mean values (valid or invalid daily averages) and the availability of daily mean values (days declared valid or days declared invalid).

2.3.2.14 If short-term mean values are used, classified or stored for a limit comparison, these shall be rounded in accordance with Section 5.4 of VDI 4204 Sheet 1 (issue March 2022). Long-term mean values shall be rounded in accordance with Section 5.4 of VDI 4204 Sheet 1 (issue March 2022). [regarding sections 6.4.1, 6.4.2, 6.5.2 and 6.6 of DIN EN 17255-3 in conjunction with Sections 8.11, 8.12, 8.13 and 9.1 of DIN EN 17255-1]

2.3.3 Additional requirements for remote emission data transmission systems

2.3.3.1 According to § 31 (5) of the BImSchG and TA Luft number 5.3.3.5, the competent authority can prescribe the type of transmission of the measurement results of emission determinations. One possibility is the installation of a long-distance emission data transmission system (EFÜ system).

EFÜ systems consist of a system installed by the operator as part of the evaluation device and a system set up by the competent authority. The following requirements are addressed to the system installed by the operator.

2.3.3.2 The following functionalities shall be fulfilled by an EFÜ system:

a) Transfer of all validated short-term mean values of the emission measured values, reference and operating quantities in accordance with the requirements of the approval decision or the competent authority

b) Transfer of state identifiers (status and operating mode) to each short-term mean value

c) Transfer of the respective valid limit values and the standard deviation to each measurement variable

d) Compliance with the EFÜ interface definition in the current version

e) daily automatic data transmission to the competent authority

f) retrieval of data at any time up to the current point in time by the competent authority

g) spontaneous automatic data delivery by the operator system in case of limit values violations and other events

h) Retrieval of values and data from at least the last 24 months after the end of the reporting period by the competent authority

i) Transmission of explanatory short texts on events by the operator

j) Transmission of a comment with the transmission of the results

k) Possibility of transmitting process images of the supervised plant

l) Self-registration of operator systems with the system of the competent authority with logging

m) Transfer of data models with logging

n) Transfer of data model changes within 24 hours

2.3.3.3 It must be ensured that no unauthorised intrusion into the system can take place from outside via the data transmission line. In the event of incorrect connections, suitable precautions must be taken to prevent data transmission and the connection must be terminated. The number of unsuccessful retries must be limited.

2.3.4 Carrying out the suitability test of data collection and evaluation devices

2.3.4.1 During the suitability test, it is necessary to determine for which evaluation tasks in accordance with legal requirements the tested data collection and evaluation device is suitable.

2.3.4.2 If the data acquisition and evaluation device allows long-distance emission data transmission, the test must be carried out with a similar system to that used by the supervisory authority, taking into account the EFÜ processes. The basis for this is the EFÜ interface definition in the currently valid version for the operator system. The software versions of both systems must be named.

2.4 Measuring equipment for long-term sampling

2.4.1 The requirements of 2.1.1, 2.1.2 and 2.1.3 as well as 2.2.1.4 apply.

2.4.2 The suitability test is to be carried out in compliance with the minimum requirements and testing procedures of VDI 4203 Sheet 1 (issue September 2017).

Note: Annex A3 to VDI 4203 Sheet 1 (issue September 2017) describes the minimum requirements and requirements for the performance of measurements using long-term sampling systems. The application of DIN EN 15267-3 (issue March 2008) takes place mutatis mutandis.

2.5 Measuring devices as defined in 17. Federal Immission Control Ordinance for temperature monitoring in the post-burning zone

For radiation pyrometers or other suitable temperature measuring devices, excluding thermocouples and their transmitters (see under 4.1.5), the requirements of 2.1.1, 2.1.2, 2.1.3, 2.2.1.3 and 2.2.1.4 apply. Where applicable, the requirements of DIN EN 15267-3 (issue March 2008) and VDI 4203 Sheet 1 (issue September 2017) shall apply mutatis mutandis.

2.6 Requirements for automatic measuring devices for recurrent emission determination

2.6.1 The requirements of 2.1.1, 2.1.2, 2.1.3 and 2.2.1.2, sentence 1, apply.

2.6.2 The suitability test is to be carried out in compliance with the minimum requirements and testing procedures of DIN EN 15267-4 (issue May 2017).

3. Test institutes, procedures for publication and certification of suitable measuring, data acquisition and evaluation devices

3.1 Test institutes

3.1.1 The suitability test is carried out by test institutes that meet the requirements of Annex B to Directive VDI 4203 Sheet 1 (issue September 2017).

3.1.2 Audits or audit reports from audit institutes of other Member States of the EU or the European Economic Area (EEA) are recognised as equivalent if the requirements of VDI 4203 Sheet 1 (issue September 2017) Annex B4 are met. Deviating from this, the suitability test for portable measuring devices must have been carried out according to the requirements of DIN EN 15267-4 (issue May 2017).

3.2 Procedure for the publication of suitable measuring or data acquisition and evaluation devices as well as certification

3.2.1 After completion of a suitability test, the test institute submits a test report on the results and all other necessary documents to a specialist committee. This examines the documents in terms of content and plausibility and prepares a technical opinion, which serves as the basis for advising the Federal/Regional Working Group for Immission Protection (LAI), Committee on Air Quality/Effective Questions/Transport.

3.2.2 If the coordination between the competent state authorities in the LAI committee on air quality/impact issues/traffic leads to a positive overall assessment, the suitability of the tested measuring or data acquisition and evaluation device should be published in the Federal Gazette.

3.2.3 The suitability of the measuring or data acquisition and evaluation devices is published by the Federal Environment Agency in the Federal Gazette. Subsequently, the measuring or data collection and evaluation

devices will be certified according to the DIN EN 15267 series (DIN EN 15267-1, issue July 2009; DIN EN 15267-2, issue July 2009).

3.2.4 Certificates are generally issued for a period of five years. After expiry of the validity, the certificate will be extended if the measuring device continues to comply with the suitability-tested condition and the requirements according to DIN EN 15267-2 (issue July 2009) are met. If adjustments to the legal or technical requirements are to be taken into account in the course of the extension, compliance with the new requirements must be checked with the involvement of the specialist committee mentioned under 3.2.1.

3.2.5 If it is determined that a measuring or data acquisition and evaluation device no longer corresponds to the suitability-tested condition or that the requirements of DIN EN 15267-2 (issue July 2009) are not met, this can lead to the loss of the certificate.

3.2.6 The test institute must make the test documents and results accessible to the competent state authorities and keep them for at least ten years.

4. Use of continuously operating measuring and data collection and evaluation devices

4.1 Selection and installation

4.1.1 If measuring or data acquisition and evaluation devices are used beyond the announced framework, the monitoring authority can demand the statement of the test institute that carried out the suitability test (general clause).

4.1.2 The competent authority should demand that the measuring or data acquisition and evaluation devices be installed in accordance with Directive VDI 3950 Part 1 (issue June 2018) and by a body that has an announcement for the area of activity of group II number 1 in accordance with Annex 1: the Forty-First Ordinance for the Implementation of the Federal Immission Control Act (Notification Ordinance - 41st Federal Immission Control Ordinance) of 2 May 2013

(Federal Law Gazette I p. 973, 1001, 3756, last amended by Article 15 of the law of 10 August 2021 (Federal Law Gazette I p. 3436)).

4.1.3 In the case of measuring devices for the exhaust gas volume flow, the display range must be selected in such a way that the highest volume flow to be expected at the respective installation point is assigned to 80% of the measuring range end value.

4.1.4 For measuring devices for moisture content, the display range shall be selected in such a way that the measurement signals in normal operation are in the upper third of the display range.

4.1.5 The following quality requirements apply to measuring devices for determining the temperature at the end of the post-burning zone using thermocouples:

Thermocouples (consisting of a sheathed thermocouple with a suitable protective cover):

- Measuring range suitable (depending on thermocouple type)
- Conformity of production with DIN EN 60584-1 (issue July 2014). The conformity can be certified by an ISO 9001 (issue September 2015) certified manufacturer.
- Quality class according to DIN EN 60584-1 (issue July 2014) (minimum requirement: Quality class 2)

Transducer with comparator compensation:

- the equipment must comply with the industrial standard (DIN EN 61508 sheets 1 to 7: Issue February 2011)
- the accuracy shall be at least 2% of the end of the measurement range according to E 4.1

4.1.6 Care must be taken to ensure that data acquisition and evaluation devices are set up so that they are protected against vibrations.

4.2 Application, calibration, functional testing and maintenance

4.2.1 During the operation of the system, which is subject to mandatory monitoring, the proper functioning of the measuring, data acquisition and evaluation devices must be ensured.

The system's status signals for verifying the operating condition must be recorded during the entire service life of the data acquisition and evaluation device.

Note 1: The measuring, data acquisition and evaluation devices should be put into operation sufficiently before the start of operation requiring monitoring in order to ensure their functionality at the start of operation requiring monitoring.

The availability of the measuring devices must reach at least 95% of the operation subject to monitoring. Measuring equipment for use on installations of the 13th and 17th Federal Immission Control Ordinances must also comply with the availability referred to in 2.2.1.3. The measuring devices for the determination of the oxygen reference content shall achieve availability of at least 98%.

For evaluation devices, the availability must be at least 99%.

Note 2: When determining the operating time of data acquisition and evaluation devices, inspection times for longer planned plant downtimes may have to be taken into account.

4.2.2 Comparative measurements are not required for functional tests (AST) of measuring devices for monitoring the minimum temperature.

4.2.3 In the case of continuous evaluation, the substitute value for the reference variable must be specified in consultation with the competent authority as part of the calibration.

4.2.4 The competent authority should work towards ensuring that devices within the meaning of this regulation are only operated by trained and instructed specialist personnel in compliance with the manufacturer's operating instructions.

4.2.5 The competent authority should recommend that the operator of the measuring, data acquisition and evaluation equipment concludes a maintenance contract for the regular inspection of the equipment within the meaning of this regulation. The maintenance contract can be waived if the operator has qualified personnel and appropriate maintenance facilities.

4.3 Use of measuring devices to monitor dust separators (qualitative measurement)

4.3.1 If an alarm is triggered due to a fault in the dust separator (alarm threshold exceeded), the operating personnel must immediately initiate measures to restore the functionality of the exhaust gas cleaning system.

4.3.2 The implementation of the measure must be documented as a comment on the event report or in the operations log.

4.4 Use of measuring devices to determine the soot number

4.4.1 The requirements of VDI 4203 Sheet 1 (issue September 2017), Annex A2(c) to (f) should be taken into account with regard to the use.

4.4.2 The installation, commissioning and calibration of the measuring equipment will be carried out in accordance with VDI 2066 Sheet 8 (issue September 1995). For calibration in accordance with Section 8.4 of VDI 2066 Sheet 8 (issue September 1995), the requirements of VDI 3950 Sheet 1 (issue June 2018) must be taken into account.

4.5 Use of measuring devices to determine the exhaust gas velocity and volume flow

With regard to the application, DIN EN ISO 16911-2 (issue June 2013) must be observed.

Note: Special provisions may be made for certain areas of application (e.g. within the scope of the Gas Emissions Trading Act (TEHG)).

4.6 Use of measuring devices to monitor the minimum temperature

4.6.1 The competent authority shall require the calibration and functional testing of the measuring devices to be carried out in accordance with the specific requirements set out in Annex E7.

4.6.2 When using thermocouples, the competent authority should require of the operator that if a thermocouple that is part of a temperature measuring device according to number 4.1.5 fails, it must be replaced immediately by a spare measuring device that is to be kept available and is identical.

4.7 Use of data collection and evaluation devices

4.7.1 In consultation with the operator, the competent authority in each case should determine the start and end of operation subject to monitoring and assessment, as well as the individual operating modes of the system. The respective criteria are to be defined using clear parameters to be recorded by the data recording and evaluation device. In particular, the start and, if necessary, departure processes must be taken into account.

In the case of systems within the scope of the TEHG, all processes that can emit greenhouse gases must be included in the operation that is subject to monitoring.

It is important to ensure that starting periods that are relevant for the emission performance of the installation due to their frequency or duration are included in the emission assessment.

Note: The following generally applies to firing installations: The operation subject to assessment begins when the “Fire on” signal is present and the oxygen content in the exhaust gas as a volume fraction falls below 16% or when the generator in energy systems produces the first electricity; the operation requiring assessment ends when the “fire on” signal is no longer present and the oxygen content exceeds 16% by volume.

4.7.2 Other operating states (such as ARE failures) are to be characterised by clear parameters.

4.7.3 An averaging time of 30 minutes must be provided for the evaluation (specific rules see Annexes C to I). Additional regulations must be met when used in systems where short-term significant or strongly fluctuating emissions can occur.

4.7.4 For start-up and shut-down processes, the competent authority must make special regulations in individual cases. Options for classification are set out in Annexes C to I.

4.7.5 If operating or reference variables (e.g. the exhaust gas volume flow or moisture content) are not determined continuously, the type of evaluation must be determined by the competent authority in each individual case.

4.7.6 When using data acquisition and evaluation devices with long-distance emission data transmission, the type of data transmission must be agreed between the operator and the competent authority.

4.7.7 For the parametrisation of data acquisition and evaluation devices for the continuous monitoring of total C in asphalt mixing plants, the federal specifications for the parametrisation in the currently valid version must be observed.

4.8 Use of portable automatic measuring devices

4.8.1 If portable automatic measuring devices are used for recurring measurements, they must be certified according to DIN EN 15267-4 as soon as suitable, certified systems published in the Federal Gazette are available for the respective measured variable.

4.8.2 Contrary to number 4.8.1, portable automatic measuring devices that are already in use and have been tested for their suitability but are not certified can continue to be used as long as the quality assurance criteria are met and no significant changes have been made to the measuring devices.

4.9 Use of measuring equipment for long-term sampling

4.9.1 The competent authority should, if not already required by legal obligations from the operator, determine that a body that has an announcement for the area of activity of group II number 1 according to Annex 1 of the 41st Federal Immission Control Ordinance shall carry out at least one review of the functionality of the system for long-term sampling every year. The principles of DIN EN 14181 (issue February 2015) must be observed.

4.9.2 In the order or condition regarding the installation of the measuring devices for the continuous monitoring of the emissions of special substances, the operator of the installation should be required to have the measuring devices installed and checked by a body that has a familiarity with the area of activity of group II number 1 according to the Annex 1 of the 41st Federal Immission Control Ordinance. For this purpose, at least three comparative measurements shall be carried out using a standard reference measurement method in compliance with the relevant VDI guidelines and DIN standards. A new inspection is required in the event of a significant change in the way the system or the measuring device is operated, but no later than after one year. If necessary, the sampling times can be shortened; The respective suitability test provides information on this.

Berlin, 31 July 2023

C I 2 Ref.: AG C I 2 - 5025/001-2023.0001

Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

By order

Dr Hummel

Annex A

A Definitions, abbreviations, examples of the application of status identifiers for short-term mean values

A 1 Definitions and terminology

The following terms and definitions apply:

A 1.1 **Exhaust gas purification failure**

Unforeseeable failure or malfunction of the exhaust gas cleaning system. The maximum duration of maintaining system operation is limited.

A 1.2 **Automatic measuring device (AMS)**

Measuring device permanently installed on the installation for continuous monitoring of emissions or measurement of reference values (DIN EN 14181, issue February 2015)

Note 1: An automatic measuring device is a process that can be traced back to a reference process.

Note 2: In addition to the analyser, an automatic measuring system also includes devices for sampling (e.g. sampling probe, sample gas lines, volume flow meters, controllers, feed pumps) and for sample preparation (e.g. dust filters, drying devices, converters, dilution devices). This definition also includes testing and adjustment devices required for periodic functional testing.

Note 3: In the case of suitability-tested measuring devices, the suitability test report also belongs to the automatic measuring device.

A 1.3 **Mode of operation of the plant**

The operating status of the plant, which is important for the evaluation of continuous emission measurements, is characterised by unique signals and/or parameters.

Note: An operating mode can e.g. be assigned to individual fuels for which specific emission limit values apply (e.g. in the case of mixed

firing: Operating mode 1: oil operation, operating mode 2: gas operation, operating mode 3: start-up, operating mode 4: stand-by).

A 1.4 **Plant operation subject to assessment**

Part of the system operation that is subject to monitoring, in which compliance with specified emission limits is to be monitored (VDI 4204-1, issue March 2022)

2. Mode subject to reporting

Plant operating mode or modes during which there is a reporting obligation for a specific regulatory requirement (DIN EN 17255-1, issue October 2019)

Note 1: Depending on the application, the reporting modes according to DIN EN 17225-1 include the plant operation subject to monitoring or the system operation subject to assessment.

A 1.1 **Reference value**

Fixed physical or chemical value needed to convert the measurement to specified conditions.

Note 1: Reference values are e.g. temperature, pressure, water vapour content and oxygen concentration.

Note 2: The exhaust gas volume flow is not a reference value.

A 1.2 **Rounded short-term or long-term mean value**

Short-term or long-term mean value rounded in accordance with section 5.4 of VDI 4204 Sheet 1 (issue March 2022)

Note 1: The rounded short-term or long-term mean value is usually validated.

Note 2: A time reference and the status identifier belong to the rounded short-term or long-term mean value.

A 1.3 **Calibration**

Determination of a calibration function of (temporary) limited validity applicable to an AMS at a given measuring station (DIN EN 15267-3, issue March 2008)

A 1.4 **Short-term mean value**

Arithmetic mean of the valid FLD averaged over the averaging time

Note: Usual averaging times for short-term averages are 3 minutes, 10 minutes, 30 minutes (half-hourly mean value) and 1 hour.

A 1.5 **Long-term mean value**

Arithmetic mean of the valid short-term mean values averaged over the averaging period, with the exception of short-term mean values that do not require assessment (see Section 8.8 of VDI 4204 Sheet 1, issue March 2022)

Note: Common averaging periods for long-term mean values are one day, one month and one year.

A 1.6 **Measuring signal**

Output of an AMS in analogue or digital form converted into a measured value using the calibration function (DIN EN 15267-3, issue March 2008)

A 1.7 **Measuring value**

Estimate of the measured value derived from the measurement signal (DIN EN 14181, issue February 2015)

Note 1: This usually includes calculations based on calibration and conversions into desired quantities.

Note 2: A measured value is a short-term mean value.

A 1.8 **Averaging period**

Period over which an arithmetic or time-weighted average of a concentration is formed (DIN EN 15267-3, issue March 2008)

A 1.9 **Raw data**

Value received directly from the AMS, optionally after scaling to e.g. units representing concentrations and associated status signals (DIN EN 17255-1, issue October 2019)

A 1.10 **Status signal**

Binary value or enumerated value from the system, the AMS or the operating personnel that indicates a specific operating state (DIN EN 17255-1, issue October 2019)

Note: A distinction is made between measuring value-related status signals (status of a measured value) and plant-related status signals (plant operating status).

A 1.11 **Plant operation subject to monitoring**

Operation of the plant in an emission-relevant mode (VDI 4204 sheet 1, issue March 2022)

A 1.12 **Availability**

Proportion of the total monitoring period for which usable measurement results are available (DIN EN 15267-3, issue March 2008)

Note 1: The measuring device may not be available due to faults or maintenance (including zero and reference point controls).

Note 2: The measuring and data collection and evaluation devices must meet certain requirements for availability during the suitability test (cf. 2.2.1.3 and cf. DIN EN 17255-3 Section 6.8.1) and during operation (cf. 4.2.1).

Note 3: The monitoring period is usually the calendar year.

A 1.13 **Time reference**

Usually the point in time at the end of the averaging period.

Note: It can also indicate the beginning and end of the averaging period.

A 2 Abbreviations

AMS	automatic measuring device
ARE	exhaust gas purification device
AST	annual functional testing
BA	operating mode
BeP	Federal uniform practice in the monitoring of emissions
EFÜ	remote emission data transmission
FLD	basic data
HMW	half-hourly mean value
JMW	annual mean value
LTA	long-term mean value
MM	monthly mass, monthly value of mass
MMV	monthly mean value of mass ratios
MWS	measurement status
OSSTA	normalised short-term mean value converted to oxygen reference value
QAL1	first Quality Assurance Level
QAL2	second Quality Assurance Level
QAL3	third Quality Assurance Level
SAG	sulphur separation degree
SMW	hourly mean value
SSTA	standardised short-term mean value
STA	short-term mean value
TEHG	Greenhouse Gas Emissions Trading Act
TGW	daily limit value
TM	daily mass
TMW	daily mean value
TNBZ	temperature in the post-burning zone (post-burning

	temperature)
VSTA	validated short-term mean value
3-min-MW	average over 3 minutes (three-minute mean value)
10-min-MW	average over 10 minutes (ten-minute mean value)

A 3 Examples of the application of status identifiers for short-term average values

Example 1

Plant (TA Luft) in operation requiring monitoring, measurement of carbon monoxide in normal operation, no special events in the system, operating mode 1 (defined here as fuel operated with oil)

For the rounded, validated half-hourly mean value of 273 mg/m³ carbon monoxide, the status identifier for system in operation, valid mean value, normal operation and operating mode 1 is saved: 273; G; G; B; 1 or 273 GGB 1

Example 2

Plant (TA Luft) in operation requiring monitoring, measurement for carbon monoxide in normal operation, oxygen reference measurement failed for 12 minutes, no special events in the system, operating mode 1 (normal operation)

For the rounded, validated half-hourly mean value of 324 mg/m³ carbon monoxide, the status identifier for the system in operation, the valid measured value was calculated with a substitute value (for oxygen), normal operation and operating mode 1 is saved: 324; G; E; B; 1 or 324 GEB 1

Example 3

Plant of type of the 13th Federal Immission Control Ordinance in operation subject to monitoring, measuring device for sulphur dioxide signals fault for 2 minutes and automatic zero and reference point check (maintenance) for 9 minutes, operating mode 1 (normal operation)

For the rounded, validated half-hourly mean value of 115 mg/m³ sulphur dioxide (mean value over 19 minutes), the status identifier for system in

operation, invalid due to malfunction of the measuring device, normal operation and operating mode 1 is saved: 115 G; S; B; 1 or 115 GSB 1

Note: The measured value status 1 “invalid due to malfunction” has a higher priority for < 2/3 than “invalid due to maintenance”.

Example 4

Plant of type of the 13th Federal Immission Control Ordinance out of operation for 3 min and in operation requiring monitoring for 27 minutes, measuring device for carbon monoxide in normal operation, 3 minutes operating mode 0 (system out of operation (not subject to monitoring)), 12 minutes operating mode 2 (starting with fuel oil (oxygen content ≥ 16 vol %, no assessment required)), 15 minutes operating mode 3 (start-up operation requiring assessment (switching on the coal mills/stabilization, oxygen content < 16 vol%))

For the rounded, validated half-hourly mean value of 10 mg/m³ carbon monoxide (mean value over 27 minutes), the status identifier for system in operation, invalid mean value due to other reasons (start-up), start-up operation/start-up and operating mode 3 is saved: 10; G; I, A; 3 or 10 GIA 3

Example 5

Plant out of operation during the entire averaging period (not subject to monitoring), measuring device for dust in normal operation, operating mode 0

No mean value is formed. The following information and the status identifier for the system out of service are saved:

- in the data memory, especially in the case of long-distance emission transmission: 0; X; N; N; 0

  and

- In the text document (table of mean values):
  - ; X; N; N; 0 or - XNN 0

Note 1: The storage of short-term mean values with status code for system status “X” is optional.

Note 2: If the system status is “X”, the identifier “N” is automatically output for measured value status 1 and 2.

Annex B

B Classification and Data Output

B 1 Classification of short-term mean values

3. The short-term mean values according to 2.3.2.14 are to be classified. The respective class classification shall be selected according to the exposures in the annexes for the different installations (see Annexes 24.1.1.1B to 52.1.1.1B).

4. Short-time mean values with plant status G are to be counted in special class S6 (sum of the short-term mean values for operation subject to monitoring).

5. Short-term mean values with the status identifiers GNN and GNA are to be recorded in special class S8.

6. Valid short-term mean values with MWS1 K, E, M or G, which exceed the limit for the short-term mean value shall be entered in special class S1. This excludes short-term mean values according to 16..

7. The classes are to be formed by appropriate division of the limit value for the short-term average by the number of classes specified in each case. The limit for the short-term mean value is at the upper class limit of the highest class.

   For classification into classes M1 to M20, the short-term mean values shall be considered with one digit more than the number of places of the upper class limit and rounded according to section 5.4 of VDI 4204 sheet 1 (issue March 2022).

8. Valid short-term mean values with the MWS1 K are also to be recorded in the special class S9. At the end of each week (Monday > 00:00 to Sunday 24:00) it must be checked whether more than 5% of the short-term mean values are outside the valid calibration range.

   If that is the case, the special class S10 should be increased by the number 1. If more than 40% of the short-term averages are outside the valid calibration range within one week, the special class S10 shall be

increased by the number 6. After the exam at the end of the week, the special class S9 is reset to zero. If the meter reading in special class S10 exceeds 5, in addition to 18. the automatic event message “New calibration required!” must be made. If the counter reading is ≤ 5, there is no event message.

Note: A reset of classes S9 and S10 is also carried out in the context of annual function control or after calibration.

9. Valid short-term mean values with the MWS1 E shall also be entered in special class S3.

10. Short-term mean values with the MWS1 I that are invalid due to installation, e.g. by starting or shutting down (change: non-monitoring operation ↔ operation subject to monitoring) during the averaging period, shall be included in special class S7.

11. Invalid short-term mean values with the MWS1 S shall be entered in special class S4.

12. Invalid short-term mean values with the MWS1 W shall be entered in special class S5.

13. Invalid short-term mean values with the MWS1 U shall be entered in special class S8.

14. Short-term mean values with MWS1 I which are invalid for other reasons shall be entered in special class S2.

15. Short-term mean values with the MWS2 R shall also be recorded in special class S11.

16. The evaluation device shall be able to record valid short-term mean values with the MWS1 K, E, M or G and MWS2 A exceeding the short-term mean value limit value in the special class S14 or S17 according to Annexes 24.1.1.1B, 26.1.1.1A, 41.1.1.1A and 52.1.1.1B. Then there is no classification in special class S1.

17. Valid short-term mean values with the MWS1 M are also to be recorded in the special class S18.

18. Whenever a short-term mean value is entered in a special class, an event report must always be generated. An exception to this is the classification in the special class S6.

The event report should contain at least the time reference, the measurement size, the number of the special class, the text of the report in short form and the value of the measurement size.

It must be possible to suppress the generation of event messages for each measurement size and special class.

19. The evaluation device should be able to record short-term mean values outside of the operation subject to monitoring to prove the system status in a special class.

A 1 Classification of long-term mean values

20. The long-term mean values according to 2.3.2.14 are to be classified. The classification shall be selected according to the exposures in the annexes for the different installations (see Annexes 24.1.1.1B to 52.1.1.1B).

21. Valid daily mean values with the status identifier G or V that exceed the limit value for the daily mean value shall be recorded in the special class TS1.

22. Valid daily mean values with status identifiers G or V that do not exceed the daily mean limit shall be recorded in ten classes T1 to T10. The classes are formed by dividing the limit value by 10. The classes have the same width. The limit is on the upper class limit of the highest class.

For classification, the valid daily mean values are to be considered with one digit more than the number of digits of the upper class limit and rounded according to Section 5.4 of VDI 4204 Sheet 1 (issue March 2022)

23. Invalid daily mean values with the status identifier F or U shall be entered in special class TS2.

24. For each entry of a long-term mean value in a special class, 18. applies accordingly.

A 1 Data Output

The data collection and evaluation device shall comply with the requirements for reporting and summary statistics referred to in DIN EN 17255-1 Chapter 9.

In addition, the requirements of Annexes B to 52.1.1.1B are met.

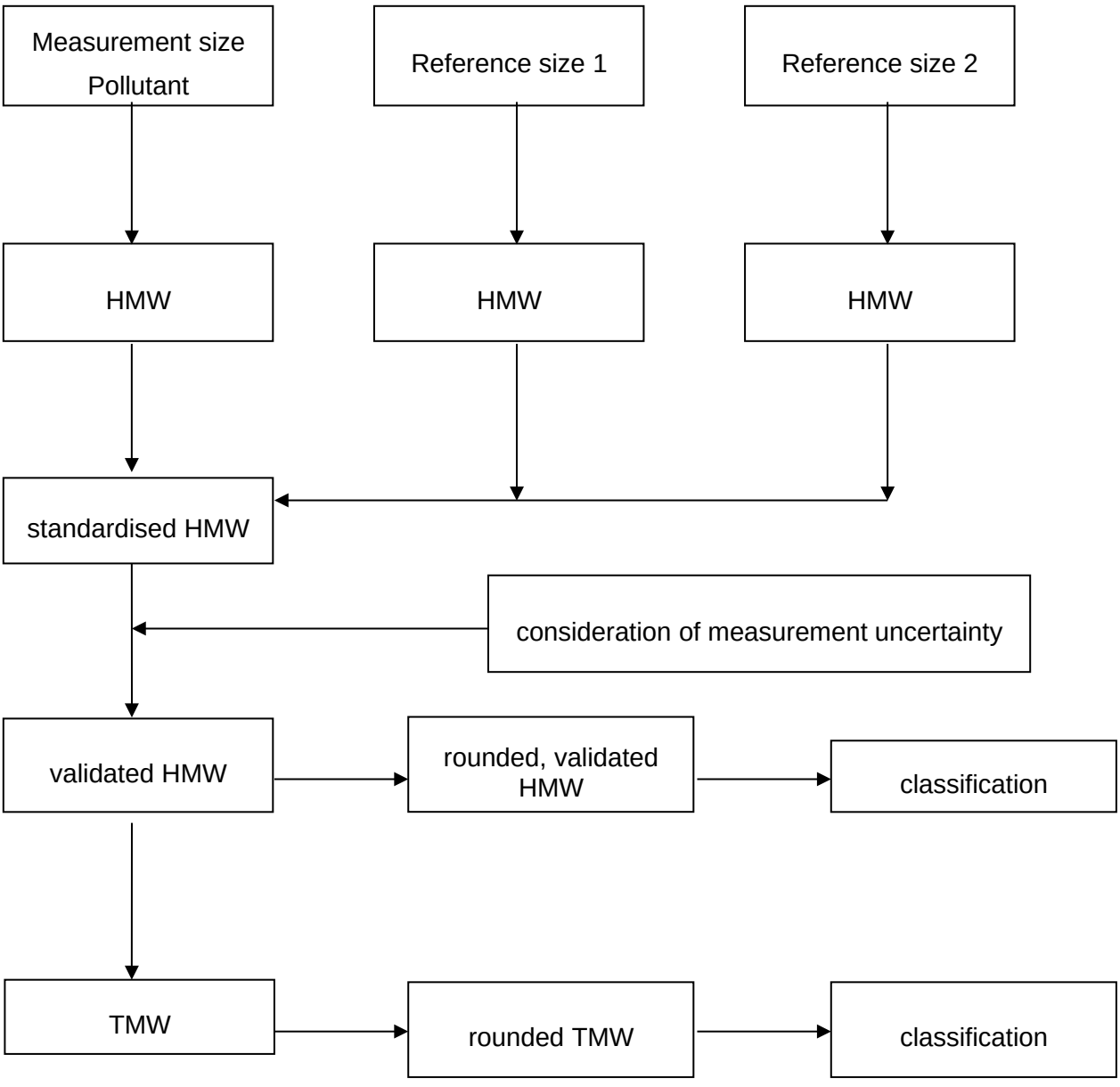
Annex C

B Requirements for measuring and data collection and evaluation devices for installations within the meaning of TA Luft

B 1 Formation of the mean values to be classified

The formation of the mean values to be classified is shown schematically in Figure Figure C 1 using the example of the half-hourly and daily mean values.

Figure C 1: Formation of the mean values to be classified



B 2 Classification of short-term mean values (HMW; 3-min MW of soot level)

The valid short-term mean values are classified as follows (see Figure Figure C 2):

- Classes M1 to M20 of the same width for values up to twice the daily mean limit, this value is at the upper class limit of class M20.
- The overruns are to be classified in class S1, with the exception of KMW of the special classes S14 or S17

Note: For the evaluation of measuring devices for monitoring dust separators (see also Chapter 2.2.2) in accordance with TA Luft point 5.3.3.2(1), Annex 48.1.1.1A 1.3 shall apply, mutatis mutandis.

B 3 Special Classes

The following special classes should be provided (see Figure Figure C 2):

S1 limit value exceeded (valid mean value; see Annex 6.)

S2 invalid for other reasons (see Annex 14.)

S3 calculated with substitute value for reference values (valid mean value;
see Annex 9.)

S4 invalid due to failure of the measuring device (see Annex 11.)

S5 invalid due to maintenance of the measuring device (see Annex 12.)

S6 operating time counter (operation subject to monitoring; see Annex 4.)

S7 invalid for plant-related reasons (see Annex 10.)

S8 not subject to assessment (see Annex 5.) and implausible values (see Annex 13.)

S9 outside calibration range, short-term memory (valid mean value;
see Annex 8.)

S10 outside calibration range, long-term storage (see Annex 8.)

S11 ARE failure (see Annex 15.)

Note: When measuring the soot level, the special classes S3 and S9 to S11 are not occupied.

S14 limit value exceeded for start-up/shutdown operation (valid mean value; not taken into account in daily mean formation)

or

S17 limit value exceeded for start-up/shutdown operation (valid mean value; consideration in daily mean value formation)

Note: In class S14 or S17, valid short-term mean values shall be classified where, for technical reasons, twice the daily average emission limit value cannot be prevented during the approach/departure operation. The competent authority shall determine whether the valid mean values that exceed the limit value for the short-term mean value in case of approach/departure operations are not to be taken into account (S14) or should be taken into account (S17).

S18 measuring range exceeded (see Annex 17.)

B 4 Classification of daily mean values (TMW)

25. The short-term mean values in special class S14 are not taken into account in the formation of daily mean values.

26. The daily mean values are classified according to Annexes 21. to 24. (see Figure Figure C 2).

Note: Annex 38. applies analogously to systems in which the degree of sulphur emissions is to be monitored.

TS4: Daily mean values at which the sulphur emission level is respected.

TS5: Daily mean values at which the sulphur emission level is not met.

Figure C 2: Classification using the example of half-hour and daily mean values

M1	M2	..... valid, limit value for HMW met	M20	S1 valid, limit value exceeded for HMW	S2 invalid for other reasons	S3 valid, calculated with replacement value	S4 invalid due to disruption of the measuring device	S5 invalid due to maintenance of the measuring device	S6 operating time counter	S7 invalid, plant-dependent	S8 not subject to assessment and implausible	S9 valid, outside calibration range, short-term storage	S10 valid, outside calibration range, long-term storage	S11 ARE failure	S14[1] or S17[2] valid, special regulation: limit value exceeded for HMW at start-up/shut down	S18 valid, measuring area exceeded

[1] HMW should not be taken into account for daily mean value formation

[2] HMW must be taken into account for daily mean value formation

T1	T2	..... valid, TGW met	T10	TS1 valid, exceeded TGW	TS2 not a valid TMW	*TS4*[*] ≤ *SEG*	*TS5*[*] > *SEG*

[*] case-by-case regulation

Annex D

A Requirements for measuring and data collection and evaluation devices for installations as defined within the meaning of the 13th Federal Immission Control Ordinance

A 1 Sulphur separation, exhaust gas cleaning, start-up/shutdown times

(§ 17 (1) and (6), § 12(2) and (3), § 19(1) of the 13th Federal Immission Control Ordinance)

27. The sulphur separation grade is determined in accordance with Section 10.1 of VDI 4204 Part 1 (issue March 2022).

The sulphur inclusion in the solid combustion residues shall be taken into account in the determination of the sulphur separation degree of the exhaust gas purification device.

28. The sulphur separation level shall be classified as a daily mean value.

29. Approach/departure times in which twice the emission limit value is exceeded for technical reasons must be classified according to Annex 24.1.1.1B 3.

30. Downtimes of the exhaust gas purifier shall be recorded in addition to the classification according to Annex 15. in the following classes:

- For each current uninterrupted event (even beyond the passing of the day or year) in special class S12,
- as a rolling sum spread across over a twelve-month period in special class S13

The criteria for the status signal shall be determined by the competent authority. The special class S12 (current ARE failure) should be automatically deleted with the start of the next downtime.

A 1 Mixing and multi-fuel combustion systems

(§ 6 of 13. Federal Immission Control Ordinance)

31. In the case of mixed and multi-fuel combustion systems, the type of continuous monitoring of emissions shall be determined by the competent

authority on a case-by-case basis, depending on the driving style and the ratio of the quantities of fuel used.

32. To reduce the effort, an evaluation can be carried out using a limit value that is flexibly adapted to the fuel mixture ratio. For this purpose, classes must be set up that capture these values for each component in percent of the respective half-hour mixing limit and the daily mean mix limit. In addition to the saved half-hourly mean values, the associated rolling limit value with oxygen reference must be saved.

33. In the case of mixed combustion systems according to § 6 of the 13th Federal Immission Control Ordinance or point 5.4.1.2.a TA Luft shall use the fuel mixture for which the highest emission limit value applies during calibration.

34. In the case of multi-fuel furnaces, it is possible to record several calibration curves assigned to the common fuels and to design the data acquisition and evaluation device in such a way that when the fuel is changed, the evaluation is switched to the assigned calibration curve. The mean values obtained from the use of different fuels should be classified and stored separately (e.g. as different operating modes).

A 1 Formation and classification of mean values

(§ 19 of 1the 13th Federal Immission Control Ordinance)

35. The formation of the short-term mean values to be classified shall be carried out in accordance with Annex 24.1.1.1B 1.

36. The short-term mean values are classified analogously to Annexes 24.1.1.1B 2 and 24.1.1.1B 3 (see Figure Figure D 1).

Note: If the sulphur separation degree is optionally classified as a half-hour mean value, the classification should be inverse.

37. In addition to the special classes set out in Annex 24.1.1.1B 3, the following special classes are introduced:

S12: current ARE failure beyond one day (see 30.)

S13: total rolling sum spread over all ARE failures within twelve months (see 30.)

38. The daily mean values are classified analogously according to Annex 24.1.1.1B 4 (see Figure Figure D 1). In addition to the TS1 and TS2 classes, the following classes are introduced:

TS3: daily mean values on which the measuring device was not in operation for more than six half-hour mean values due to malfunction or maintenance (availability not met, see 2.2.1.3).

Note: class TS3 is omitted when classifying the soot level.

TS4: daily mean values at which the sulphur separation level is maintained.

Note: the end of the class corresponds to the limit value (inverse classification)

TS5: Daily mean values at which the sulphur separation level is not met.

Alternatively or additionally, the classes T1 to T10 and TS1 can also be used for the level of sulphur separation; the TS2 and TS3 classes are always to be taken into consideration.

A 1.1 Rolling monthly mean values are according to § 19 (3) of the 13th Federal Immission Control Ordinance to calculated and published on a daily basis.

39. The annual mean value is in accordance with § 19 (2) of the 13th Federal Immission Control Ordinance and should indicate the reference year as mass concentration. In addition, the number of valid half-hourly mean values on which the formation of the annual mean value is based must be listed.

Note: The general predefined convention that the conversion of the measured values into half-hour mean values for substances whose emissions are reduced and limited by exhaust gas purification devices must be carried out only for the periods when the measured oxygen content is higher than the reference oxygen content, does not apply to the formation of the annual mean value.

A 1 Data Output

40. In addition to the event messages according to Annex 18. or 24., the following event messages are to be given:

- special class S12 (if ≥ 49 entries in a row):
  “ARE failure > 24 h” with counter output

- special class S13 (if meter reading ≥ 241):
  “ARE failure > 120 h” (output once per day)

If the meter reading is < 49 for special class S12 and < 241 for special class S13, there is no event message. In the case of special class TS4, there is no event reporting.

A 1.1 The daily data output must additionally include the rolling monthly mean value.

41. The data output to the annual financial statements must also include the following data:

- annual limit values of the measured variables concerned
- annual mean values indicating the reference year (YMW — reference year) of the last five calendar years as mass concentration and the number of half-hour mean values underlying the formation of the respective annual average (number HMW — reference year)

Figure D 1: Classification using the example of half-hour and daily mean values

M1	M2	.....	M20	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
		valid, limit value for HMW met		valid, exceeded limit value for HMW	invalid for other reasons	valid, calculated with replacement value	invalid due to disruption of the measuring device	invalid due to maintenance of the measuring device	operating time counter	invalid, plant-dependent	not subject to assessment and implausible	valid, outside calibration range, short-term storage	valid, outside calibration range, long-term storage	ARE failure	current ARE failure	ARE failures for each 12 months
															S14 [1] or S17 [2] special regulation: limit value exceeded for HMW at start-up/shut down	S18 valid, measurement exceeded

[1] HMW should not be taken into account in daily mean formation

[2] HMW must be taken into account in daily mean formation

T1	T2	.....	T10	TS1	TS2	TS3	TS4	TS5
		valid, TGW met		valid, TGW exceeded	not a valid TMW	availability of the measurement device not met each day	≥ SAG	< SAG

Annex E

A Requirements for measuring and data collection and evaluation devices for installations as defined within the meaning of the 17th Federal Immission Control Ordinance, checking combustion conditions

A 1 Continuous monitoring of minimum temperature

(§ 16 (1) number 3 in conjunction with § 6(1) or (2) and § 7(1) or (2) of the 17th Federal Immission Control Ordinance)

To monitor the minimum temperature, the post-burning temperature (TNBZ) must be determined continuously. At a suitable point in the afterburner chamber (e.g. vessel ceiling) there should be least two measuring devices in accordance with the VDI/VDE 3511 series of guidelines (VDI/VDE 3511 Sheet 4, December 2011 edition; VDI/VDE 3511 Sheet 4.2, issue February 2014; VDI/VDE 3511 Sheet 4.4, issue July 2005) or other systems tested and certified according to the DIN EN 15267 series of standards. The mean value of the respective raw data is used for recording and evaluation.

A 2 Loading and exhaust gas cleaning

(§ 17 (3) number 2 in conjunction with § 4(8) and (9), § 21(3) and (4) of the 17th Federal Immission Control Ordinance)

42. The times during which the loading of the plant was locked or interrupted shall be recorded and stored for each calendar day.

43. Downtimes of the exhaust gas cleaning device (ARE) shall be recorded in special class S12 in addition to the classification according to Annex 15. per current uninterrupted event (also beyond the end of the day and year). This class should be automatically deleted with the start of the next downtime.

The half-hour mean values for total dust produced during downtime shall be recorded in two classes, the common limit of which is formed by the emission limit for the half-hour mean value applicable to downtime.

A 1 Formation and classification of mean values

A 1.1 Pollutants

(§ 17 in conjunction with § 16(1) and (5) of the 17th Federal Immission Control Ordinance)

A 1.1.1 The formation of the mean values to be classified shall be carried out in accordance with Annex 24.1.1.1B 1.

A 1.1.2 Approach and departure times for which twice the emission limit value is exceeded for technical reasons shall be classified in class S17 in accordance with Annex 24.1.1.1B 3.

A 1.1.3 Valid half-hour mean values shall be classified in accordance with Annexes 6. and 7. (see Figure Figure E 1). Exceptions are valid half-hour mean values for dust in the event of ARE failure.

A 1.1.4 In addition to the special classes in Annex 24.1.1.1B 3, the following special classes are introduced (see 43.):

S12 current ARE failure

S15 dust in case of ARE failure $\leq$ 150 mg/m^3

S16 dust in case of ARE failure > 150 mg/m^3

A 1.1.5 The daily mean values are classified in the same way as Annex 26..

In addition to the TS1 and TS2 classes, the TS3 class is introduced:

TS3 Daily mean values on which the measuring device was out of service for more than five half-hourly mean values due to a fault or maintenance (availability not maintained, see 2.2.1.3).

A 1.1.6 The annual mean value of the measured values shall be calculated as the arithmetic mean of all valid daily mean values of the current calendar year (classes T1 to T10 and TS1). The annual mean value shall be expressed as mass concentration, indicating the reference year. In addition, the number of valid daily mean values underlying the formation of the annual mean value shall be recorded.

A 2 Monitoring of the operating sizes/reference sizes

A 2.1 **Minimum temperature**

(§ 17 (3) number 1 in conjunction with § 6(1) to (3) and § 7(1) to (3) of the 17th Federal Immission Control Ordinance)

A 2.1.1 From the raw data of the post-burning temperature, ten-minute mean values shall be formed (10-min-MW).

The valid 10-min MW shall be recorded in 20 classes of uniform width (TNBZ1 — TNBZ20). The inverse classification is to be selected in such a way that a temperature range of 400 K is covered overall and the specified minimum temperature falls on the boundary between classes 10 and 11 (see Figure Figure E 1). The lowest temperature of the temperature range shall be placed on the upper limit of class TNBZ20, the highest temperature to the lower limit of class TNBZ1.

Ten-minute mean values that are invalid due to a malfunction or maintenance of the measuring device are to be recorded in class TNBZ21.

Alternatively, classes S4 and S5 in accordance with Annex 24.1.1.1B 3 can also be used. The special classes S2 and S6 to S8 are always to be used.

44. Other operating and reference sizes

(§ 16 (1) number 4 of the 17th Federal Immission Control Ordinance)

If other operating or reference variables (e.g. exhaust gas volume flow or moisture content) are measured continuously, the type of evaluation must be determined by the competent authority on a case-by-case basis based on 43.1.1.1A 1.1.1.

A 1 Data Output

45. The daily and annual data output shall also include the following data:

- Locking or interrupting the loading according to 42.

In addition to the event messages according to Annexes 18. or 24., the following event messages are to be triggered:

- for special class S11 (if meter reading ≥ 121):
  “ARE failure > 60 h” (output once per day)

- for special class S12 (if ≥ 9 entries in a row):
  “ARE failure > 4 h” with counter output

For special class S12, the meter reading < 9 is not reported. In the case of special class S15, there is no event reporting.

The data output to the annual financial statements must also include the following entries:

- annual limit values of the measured variables concerned
- annual mean values with indication of the reference year (JMW reference year) of the past five calendar years as a mass concentration as well as the number of daily mean values (number of TMW - reference year) on which the formation of the respective annual mean value is based.

Figure E 1: Classification of half-hourly and daily mean values and the minimum temperature

M1	M2	.....	M20	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
		valid, limit value for HMW met		valid, exceeded limit value for HMW	invalid for other reasons	valid, calculated with replacement value	invalid due to disruption of the measuring device	invalid due to maintenance of the measurement device	operating time counter	invalid, plant-dependent	not requiring assessment and implausible	valid, outside calibration range, short-term storage	valid, outside calibration range, long-term storage	ARE failure	current ARE failure
												S15	S16	S17	S18
												ARE failure and dust ≤ 150 mg/m³	ARE failure and dust >150 mg/m³	Special Regulation: limit value exceeded for HMW at start-up/shutdown	valid, measurement range exceeded

T1	T2	.....	T10	TS1	TS2	TS3
		valid, TGW achieved		valid, exceeded TGW	not a valid TMW	availability of the measurement device not met on each day

TNBZ1	.....	TNBZ10	TNBZ11	.....	TNBZ20	TNBZ21
						invalid due to error or maintenance of the measuring device

A 1 Checking combustion conditions

(§ 18 (1) in conjunction with § 6(1) to (3) or § 7(1) to (3) of the 17th Federal Immission Control Ordinance)

A 1.1 Checking the minimum temperature

A 1.1.1 Definition of the measuring levels

A measuring level (measurement level 1) shall be determined at the end of the post-burning zone (above the support burners) for the approved operating conditions. The basis for this is the design data of the manufacturer or supplier. Another measuring level (measurement level 2) should be set up where the start of the post-burning zone is defined.

This measurement level shall be determined after the last addition of combustion air on the basis of design data of the manufacturer or supplier.

The level at which a uniform mixing of the combustion gases with combustion air can be assumed for the first time is defined as the start of the post-burning zone.

Due to local conditions, minor deviations in the position of measurement level 2 from the actual start of the post-burning zone are possible. This is compensated by corresponding conversions (see Figure Figure E 2).

A 1.1.2 Measurement technology

According to the current state of the art, only water-cooled extraction pyrometers with ceramic shielding are to be used for measuring the minimum temperature. A sufficiently high extraction speed should be set. Deviations from sentences 1 and 2 shall only be permitted in exceptional cases and shall be justified in the measurement report. At least one measuring device shall be used simultaneously for each specified measuring axis. The thermocouples used in the extraction pyrometers shall comply with PTB requirements 14.2 of December 2003.

A 1.1.3 Determination of the measuring points for network measurement

The temperature is measured on at least two measuring axes as a network measurement in the combustion chamber. The measuring cross-section shall be subdivided into area-like sub-areas where the measuring

points are located. The number of measuring points is 1 per approx. 2 m^2. An even point distribution over the measuring cross-section is to be ensured. Deviations from sentence 1 shall only be permitted in exceptional cases and shall be justified in the measurement report.

A 1.1.4 Raw data processing

The electronic raw data collection shall be carried out at a sampling frequency of at least 0.1 Hz (maximum 10 seconds between successive raw data). The raw data shall be condensed into 10-minute mean values.

A 1.1.5 Acceptance measurement

In order to prove that the required minimum temperature (850 or 1100 °C) is maintained, the following number of network measurements corresponding to A 1.1.3 is required for an operationally contaminated vessel:

- undisturbed continuous operation (nominal load): three network measurements over a total period of at least three hours
- deviating operating states (e.g. partial load, if approved operating state): three network measurements over a total period of at least three hours
- start-up without loading with feed materials (see § 4(8) number 1): a grid measurement for the final state of the heating phase over a period of about one hour (according to A 2.3.1).

For each measuring point determined according to A 1.1.3, the individual ten-minute mean values are converted via the temperature gradients determined according to A 1.2.2 to a fictitious measuring level, which corresponds to a residence time of two seconds (minimum residence time).

The rating criterion is the minimum temperature in each of the measurement points defined in accordance with A 1.1.3 for each individual measurement as a 10-minute mean value.

A 1.2 **Checking the residence time of exhaust gases**

A 1.2.1 Exhibition levels

Two levels of measurement (measurement level 1 and measuring level 2) are used to determine the residence time for which the minimum temperature is maintained (see A 1.1).

A 1.2.2 Determination of the temperature gradient

At the same time, temperature network measurements (three network measurements each) are to be carried out with the same system operating status in measurement levels 1 and 2.

Measurement technical framework conditions are predetermined analogous to A 1.1. (The measurement results obtained with regard to measurement level 1 can be used to check the minimum temperature according to A 1.1.)

From the raw data, the mean temperature difference $\Delta T_{1,2}$ between level 1 and 2 for the respective operating state (see also point A 1.1.5) is formed:

$$\Delta T_{1,2} = \frac{1}{n}\sum_{i=1}^{n}\left(T_{2,i} - T_{1,i}\right)$$

$T_{1\,i}$ Average temperature network measurement in the measuring level 1

$T_{2\,i}$ Average temperature network measurement in the measuring level 2

n Number of temperature network measurements in level 1 or 2.

Assuming a linear temperature curve between measurement levels 1 and 2 and beyond, the average temperature is determined for each level in the combustion chamber. Conversely, the level in the combustion chamber in which the minimum temperature of the exhaust gases is just maintained can be calculated (see Figure Figure E 2).

$$\Delta \ell_T = \left(T_1 - T_M\right) \times \frac{\Delta \ell_{1,2}}{\Delta T_{1,2}}$$

$$T_1 = \frac{1}{n}\sum_{i=1}^{n} T_{1,i}$$

The mean temperature gradient is calculated from $\Delta T_{1,2}/\Delta \ell_{1,2}$.

T_1 Mean of temperature network measurements measurement level 1

T_M Minimum exhaust gas temperature

$\Delta \ell_{1,2}$ Distance between measuring plane 1 and 2

$\Delta \ell_T$ Distance between the level in the combustion chamber at which the flue gases just maintain the minimum average temperature and measuring level 1

A 1.2.3 Determination of residence time

To determine the residence time of the exhaust gases in the range above the minimum temperature, the exhaust volume flow (e.g. at the end of the vessel) must be measured and converted to the exhaust gas conditions in the post-burning zone.

The volume flow measurement is carried out in compliance with ISO 10780 (issue November 1994) at the same time as the network measurements to check the minimum temperature. When calculating the residence time, the behaviour of an ideal flow pipe (plug flow) is assumed.

The temperature on which the volume flow is based is the average of the temperature at the beginning of the post-burning zone T_{BNBZ} and the minimum temperature. The residence time in the post-burning zone is calculated taking into account the geometric conditions and the volume flow

$$t_{VZ} = \frac{A \times (\Delta \ell + \Delta \ell_T)}{\dot{V}_{FR}}$$

$\dot{V}_{FR}$ Mean value of the volume flow of the exhaust gases in the combustion chamber (in operating condition, wet) at

$$\frac{T_{BNBZ} + T_M}{2}$$

$\Delta \ell$ Distance between start of the post-burning zone and measuring plane 1

A Cross-sectional area of the combustion chamber (for A = const.)

t_{vz} Exhaust residence time above the minimum temperature.

The evaluation criterion is the minimum residence time of 2 seconds.

A 1.3 **Uniform mixing**

A 1.3.1 Determination of uniform mixing

It can be assumed that the combustion gases are evenly mixed with combustion air if the temperature at each measuring point on both measuring levels and thus over the entire post-burning zone is maintained and the individual values for the volume content of oxygen at each of the specified measuring points do not deviate by more than 50 percent from the average volume content of oxygen for the respective network.

A 1.3.2 Measurement of oxygen content

Usually the oxygen measurement takes place simultaneously with the temperature measurements according to A 1.1 via the extraction pyrometers, so that measuring level and measuring points are identical.

A 2 Functional testing and calibration of operating measuring instruments for continuous monitoring of the minimum temperature

(§ 15 (4) and (5) in conjunction with § 16(1) number 3 of the 17th Federal Immission Control Ordinance)

A 2.1 **Function testing**

A 2.1.1 Functional testing when using sheathed thermometers

The functional testing of operating measuring instruments for the minimum temperature when using sheathed thermometers shall be carried out and documented as described below:

- Inspection of operating measuring instruments with regard to construction and installation position compared to the time of the last calibration
- Checking the equivalence of the installed operating measuring instruments with the operating measuring instruments used in the last calibration in the built-in state (can be done by submitting the system operator’s order documents)
    - Type of thermocouple

  - Type of shielding for corrosion protection
  - Length of thermocouple
- Test points for the use of on-site sheathed thermocouples
  - Type, length and connection of the compensation line
  - Installation position (position) of the thermocouple
  - Penetration depth of the thermocouple (e.g. calculated from the length of the thermocouple and the supernatant to the vessel outer wall)
  - Type and place of comparison point compensation
  - Ambient conditions on the transducer
- Plausibility check of the display of the operating measuring instruments
- Verification of raw data transmission with a constant voltage source at five points over the measuring range.
- Checking for the detection of an element break by the data acquisition and evaluation device (e.g. by disconnecting each individual operational measuring device).

A 2.1.2 Functional testing when using other temperature measuring devices

The special requirements for the measuring equipment (see notes in the publication in the Federal Gazette) must be taken into account.

A 2.2 **Calibration**

The calibration is to be carried out for the first time as soon as undisturbed operation is achieved, but no earlier than three months and no later than six months after commissioning, recurring after the specified periods and after significant changes to the furnace or the combustion chamber of the plant.

Technical changes may include, in particular:

  - change in the lining of the combustion chamber (e.g. refractory systems) of >15% of the area (the exchange of the same materials is not affected)
  - relevant change in output (>10% fuel heat output)
  - fuel (incl. water addition) outside the firing output diagram

A 2.2.1 Determination of the end of the post-burning zone

The combustion chamber temperatures are determined according to A 1.2.2 (averaging) in each case at full load and other approved operating states. Reference is also made to A 2.3.1 for the start-up operating state.

At least six network measurements (each at full and partial load) must be carried out simultaneously in measurement levels 1 and 2. For the periods of these network measurements, the mean measured values of the operational measuring devices are to be determined so that at least six data sets network measurements - operational measurement are available.

Assuming a linear temperature curve between measurement levels 1 and 2 or beyond, the end of the post-burning zone (defined as the level in the combustion chamber where the minimum residence time of 2 seconds is exactly maintained) can be determined (see Figure Figure E 2).

$$\Delta \ell_{NBZ} = \frac{t_{VZ\,min} \times \dot{V}_{FR}}{A} - \Delta \ell$$

$t_{vz\,min}$ Minimum residence time

$\Delta \ell_{NBZ}$ Distance between plane end post-burning zone and measuring level 1

$\Delta T_{1.2}$ mean temperature difference between measuring level 1 and 2

$$\Delta T_{1,2} = \frac{1}{6} \Sigma_{i=1}^{6} (T_{2,i} - T_{1,i})$$

$T_{2,i}$ Mean value of the temperature network measurement in measurement level 2

$T_{1,i}$ Mean value of the temperature network measurement in measurement level 1

$\Delta \ell_{1,2}$ Distance between measuring plane 1 and 2

The mean temperature gradient is calculated from $\Delta T_{1,2} / \Delta \ell_{1,2}$.

A 2.2.2 Method of calibration

With the help of the operational measured values for the temperature, the average temperature difference and its lower confidence limit for the converted temperature measured values of the network measurements in measurement level 1 are calculated:

T_{NBZi} converted average of the temperature network measurement i in measurement level 1 to the level at the end of the post-burning zone (2 seconds residence time)

T_{Bi} Mean value of the temperature operational measurement for the period of the network measurement i

$$T_{NBZi} = T_{1i} - \frac{\Delta T_{1,2}}{\Delta \ell_{1,2}} \Delta \ell_{NBZ}$$

Determination of the confidence limit:

$$V_B = \frac{t_{n-2} \times S}{\sqrt{n}}$$

The relationship $T_{NBZI} = f(T_{Bi})$ is determined by linear regression.

t_{n-2} T-distribution threshold (for N = n´)

S Scatter around the regression line

$n = 6$ (Total number of measurements)

$$\bar{T}_{NBZ} = \frac{1}{n} \sum_{i=1}^{n} T_{NBZi}$$

$$\bar{T}_B = \frac{1}{n} \sum_{i=1}^{n} T_{Bi}$$

$$S_{T_B T_B} = \sum_{i=1}^{n} (T_{Bi} - \bar{T}_B)^2$$

$$S^2{}_{T_B T_{NBZ}} = \sum_{i=1}^{n} \left[(T_{Bi} - \overline{T_B}) \times (T_{NBZi} - \overline{T_{NBZ}}) \right]$$

$$S_{T_{NBZ} T_{NBZ}} = \sum_{i=1}^{n} (T_{NBZi} - \bar{T}_{NBZ})^2$$

$$S^2 = \frac{S_{T_{NBZ} T_{NBZ}}}{n-2} \times \left(1 - \frac{S^2{}_{T_B T_{NBZ}}}{S_{T_B T_B} \times S_{T_{NBZ} T_{NBZ}}} \right)$$

To calibrate the operating readings, the following procedure shall be applied:

$$T_{KalB} = \quad T_{B10} + \overline{\Delta T}_{NBZ} - V_B$$

$$\overline{\Delta T}_{NBZ} = \quad \frac{1}{6}\Sigma_{i=1}^{6}(T_{NBZi} - T_{Bi})$$

$\overline{\Delta T}_{NBZ}$ average temperature difference between the end of the post-burning zone and the measured operating value

T_{KalB} calibrated operating measurement value (input emission value calculator)

T_{B10} 10-minute mean value of the temperature operating measurement

The calibration process must be carried out in full for each approved operating condition.

A 2.2.3 Parametrisation of the data collection and evaluation device

$$\Delta T_{NBZ}* = \quad \overline{\Delta T}_{NBZ} - V_B$$

ΔT_{NBZ}* is determined for each approved operating condition and calculated in the evaluation computer as a function of the output (e.g. steam output P_D); this also applies to the operating state of “shutdown”.

The function $\Delta T_{NBZ}* ¿ f(P_D)$ is parametrised.

With regard to the “start-up” operating mode, compare point A 2.3.1

A 2.3 **Special criteria**

A 2.3.1 Compliance with the combustion conditions in the operating mode “start-up”

To determine the switching point for unlocking the waste task when starting up, two network measurements each in the start-up state without charging with input materials are to be carried out for the first calibration and the calibration after a significant change in the system (according to the 17th Federal Immission Control Ordinance § 4(8) number 1).

The operating state starting up is only characterized by additional burner operation without charging with input materials (combustion system completely emptied of waste).

The start of the afterburning zone in the “start-up” operating mode is, by convention

- the additional burner level, if the secondary air supply is upstream
- the level of the last air supply with secondary air supply downstream.

The combustion conditions (minimum temperature, minimum residence time) are the basis for determining the end of the post-burning zone when “starting up”.

In the “start-up” operating mode, the volume flow to determine the residence time must be calculated or measured via the fuel consumption and the oxygen volume content of the exhaust gases.

Analogously to A 1.2.1, a network measurement for the final state of the heating-up phase and a network measurement in the lowered load state of the additional burners must be carried out in two measurement levels.

The gradient is to be determined analogous to A 1.2.2. Analogously to A 1.2.3 and E 6.2.2, the residence time and the temperature in the dwell time level TNBZ are to be determined for the two network measurements.

The switching criterion for the release (unlocking) of the waste supply results from a two-point calibration of the uncorrected ceiling temperature to the interpolated temperature switching point of the two network measurements for the switching point temperature specified in the 17th Federal Immission Control Ordinance or separately determined by the supervisory authority.

The criteria for repeating the specification of the switching criteria for the release (unlocking) of the waste supply after significant changes to the plant must be agreed with the supervisory authority.

The period after unlocking the waste supply until stationary operating conditions are reached must be agreed with the competent authority; it should not exceed two hours.

During this time, a special solution must be found for the assessment of the components that are subject to monitoring and that depend solely on the furnace. This concerns in particular the minimum temperature, carbon monoxide, total C and nitrogen oxides.

A 2.3.2 Switching criteria for the additional burners

The following switching criteria are suggested for the additional burners:

- switch on: When the target temperature class TNBZ10 is reached (10-minute value between 850 °C and 870 °C or 1100 °C and 1120 °C).
- switch off: can be performed when class TNBZ9 and lower classes are reached (> 870 °C or 1120 °C).

Controlling or regulating the additional burners via the plant's control system can contribute to reducing primary energy consumption.

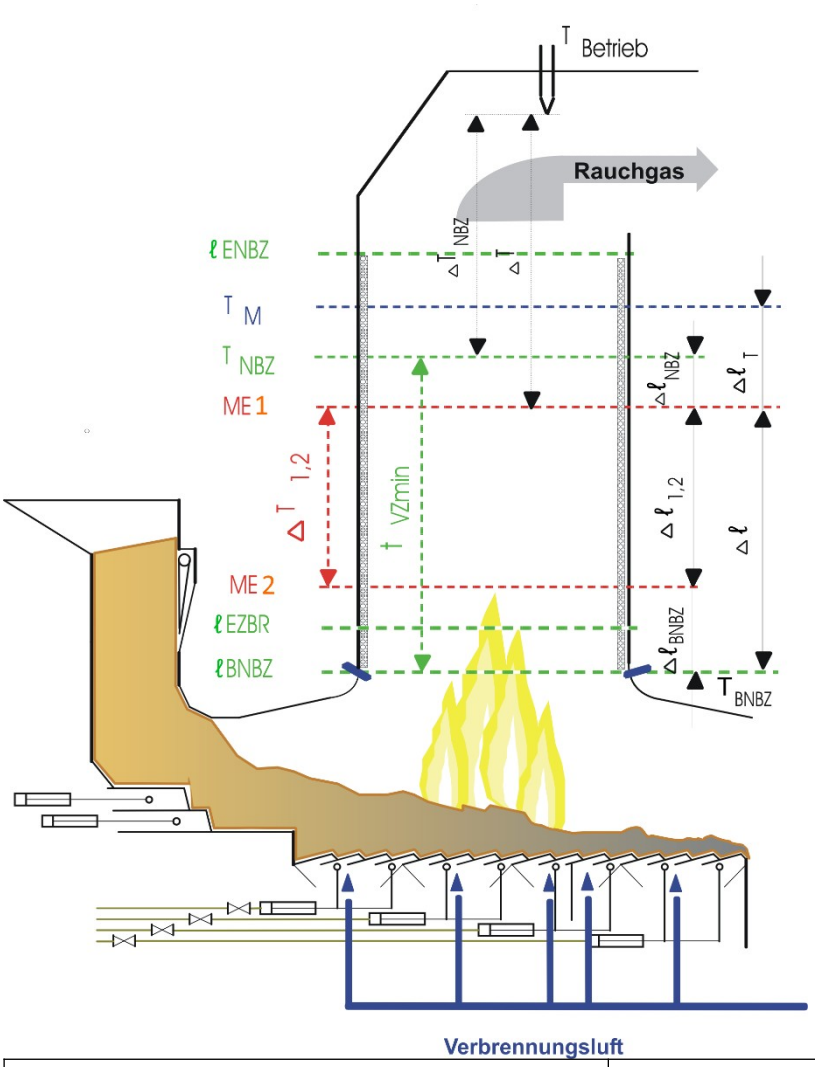
A 2.3.3 Waste loading criteria

The following criteria apply to the locking and unlocking of the waste feed:

- Locking: when a temperature in class TNBZ11 or higher class is reached (< 850 °C or 1100 °C).
- Unlocking: when a temperature is reached in class TNBZ10 or less (850 °C and 1 100 °C respectively).

Safety issues must be taken into account when locking.

Figure E 2 Presentation of the parameters using the example of an incineration plant for municipal waste



	Operation
	Flue gas
	Combustion air

Key:

T_1	mean of temperature network measurements measurement level 1		$\Delta T_{1,2}$	mean temperature difference between measuring level 1 and 2
T_2	mean of temperature network measurements measurement level 2		ℓ_{BNBZ}	height until the start of the post-burning zone
T_M	minimum exhaust gas temperature		$\Delta\ell_T$	distance between the minimum temperature level in the hearth and measurement level 1

T_B	temperature Operational Measuring Value		$\Delta\ell_{NBZ}$	distance between level end of post-burning zone and measuring level 1
T_{NBZ}	temperature at the end of the post-burning zone		$\Delta\ell$	distance between the start of the post-burning zone and the measuring plane 1
T_{BNBZ}	temperature at the beginning of the post-burning zone		$\Delta\ell_{1,2}$	distance between measuring plane 1 and 2
ΔT	temperature difference between measuring level 1 and operating measurement value		$\Delta\ell_{BNBZ}$	distance between level beginning of the post-burning zone and measuring level 2
ΔT_{NBZ}	temperature difference between the end of the post-burning zone and the measured operating value		$t_{VZ,min}$	minimum residence time = 2 s
ℓ_{EZBR}	level of additional burners		ℓ_{ENBZ}	design-related end of the post-burning zone

Annex F

B Requirements for measuring and data collection and evaluation devices for installations as defined within the meaning of the 27th Federal Immission Control Ordinance

The evaluation is outlined in Figure Figure F 1.

B 1 Continuous monitoring of the mass concentration of carbon monoxide

(§ 7 (1) of the 27th Federal Immission Control Ordinance)

The measuring device is intended to cover a measurement range from 0 to 3 000 mg/m³ (see VDI 3891 pt. 9.4.2, issue July 2015).

B 2 Loading of the plant and bypassing of the ARE

(§ 7 (1) of the 27th Federal Immission Control Ordinance)

46. To trigger the locking of the kiln entrance, the post-combustion temperature (see 48.1.1.1A 1.2.1) must be determined on a rolling basis (10 min MW per min).

47. The times when the loading of the systems is locked must be recorded and saved for each calendar day.

48. The times during which the ARE is bypassed in an emergency due to a fault in the system (bypass operation) must be recorded and saved for each calendar day.

A 1 Formation and classification of mean values

(§ 8 of the 27 Federal Immission Control Ordinance)

A 1.1 **Carbon monoxide**

A 1.1.1 The hourly mean values to be classified are to be formed in accordance with Annex 24.1.1.1B 1, with the exception of daily mean values.

A 1.1.2 The hourly mean values for carbon monoxide are classified according to 43.1.1.1A 1.1.3 and in the special classes according to Annex 24.1.1.1B 3.

A 1.2 **Monitoring the minimum temperature**

A 1.2.1 From the FLD of the post-burning temperature, ten-minute mean values shall be calculated (10-min-MW).

A 1.2.2 The 10-min mean values shall be classified as follows (see Figure Figure F 1)):

TNBZ1 Minimum temperature maintained

TNBZ2 Minimum temperature below

TNBZ3 Fault or maintenance of the measuring device

Alternatively or additionally, the classes TNBZ1 to TNBZ20 and TNBZ21 can also be taken in accordance with Annex .

Alternatively, classes S4 and S5 in accordance with Annex 24.1.1.1B 3 can also be used.

The special classes S2 and S6 to S8 are always to be used.

In addition, the duration of the shortfalls must be recorded:

TNBZU Sum of the duration of shortfalls

A 1.3 **Monitoring the functioning of the dust filter system**

(§ 7 (2) of 27. Federal Immission Control Ordinance)

A 1.3.1 When using a quantitative dust measuring device (dust monitor according to DIN EN 15859, issue August 2010, section 3.4 or dust concentration measuring device according to DIN EN 13284-2, issue February 2018), the hourly mean value according to 2.3.2.8 is evaluated.

A 1.3.2 When using a high-quality dust measuring device (leakage monitor according to DIN EN 15859, issue August 2010, section 3.5), the raw data are directly evaluated. There is no mean value formation. Even the one-time overrun of the alarm value by a raw data value within the averaging period is counted in class FS1 (see A 1.3.3) as an indication of possible excess value.

A plausible alarm threshold must be determined in coordination between the measuring device manufacturer and a body that has notification for the area of activity of group II number 1 in accordance with Annex 1 of the 41st Federal Immission Control Ordinance. If the alarm threshold is exceeded, signalling must follow (see 4.3).

A 1.3.3 The following classes are set up for monitoring the filter system (see Figure Figure F 1)

F1 limit value respected

FS1 limit value exceeded

Alternatively, classes M1 and S1 in accordance with Annex A 1.1.2 can also be used.

According to Annex 24.1.1.1B 3, the special classes S2 to S8 and S11 must still be used. When using a high-quality dust measuring device, the class S3 is omitted.

In addition, the duration of the overrun events must be recorded:

FSÜ Sum of the overrun events

A 2 Data Output

The daily and annual data output shall also include the following data:

- Locking according to 47. (in hh:mm)
- Bypass operation according to 48. (in hh:mm:ss)
- Falling short of TNBZ according to A 1.2.2 (in hh:mm)
- Events of overruns according to A 1.3.3 (in hh:mm:ss)

In addition to the event messages according to Annexes 18. or 24., the following event messages are to be triggered:

- for classes TNBZ11 to TNBZ20

“Below minimum temperature”

- Start or stop of the locking of the loading:

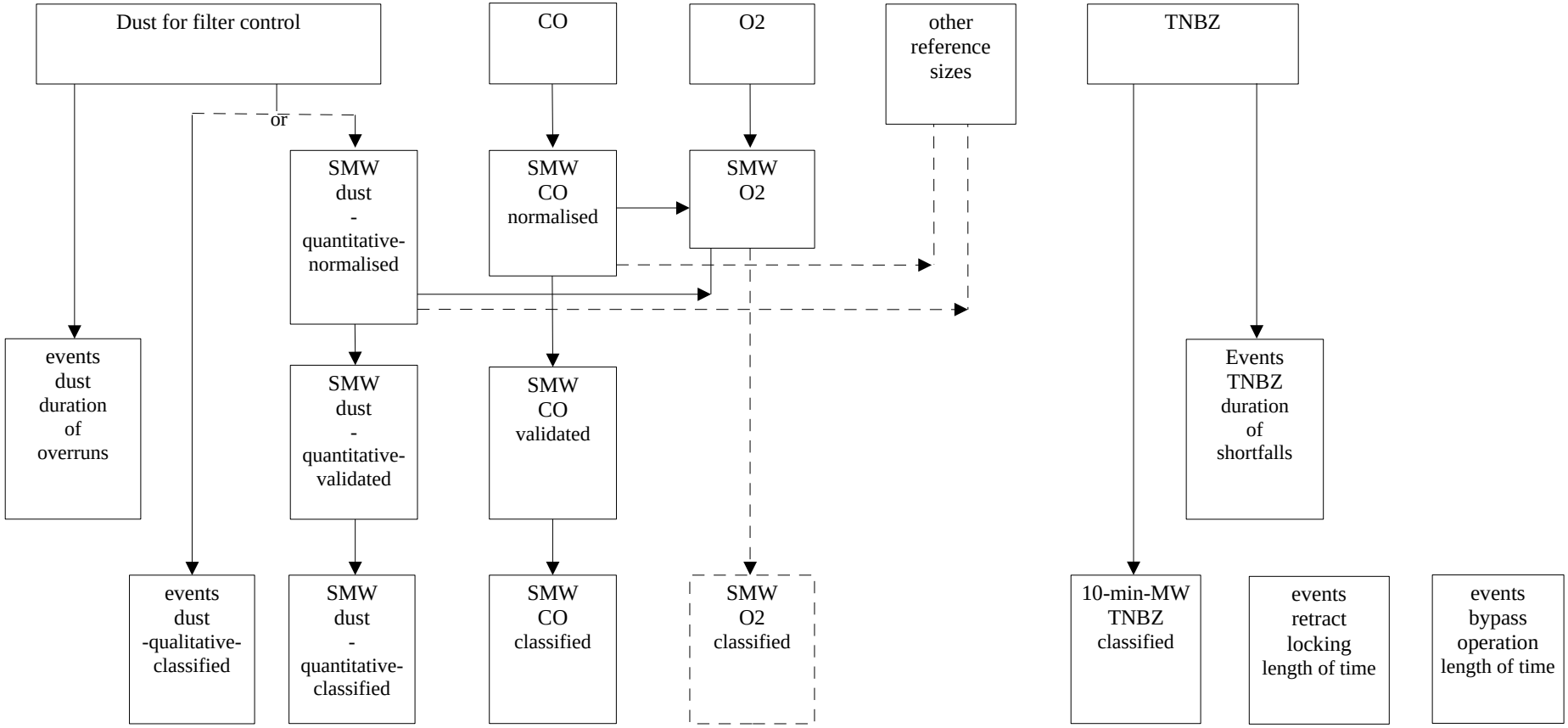
“Loading locked” or “loading open”

- Start or stop of the bypass operation:

“Start of bypass operation” or “end of bypass operation”

For special class S12, the meter reading < 9 is not reported. In the case of special class S15, there is no event reporting.

Figure F 1 Evaluation of the Annexes of the 27th Federal Immission Control Ordinance



Annex G

B Requirements for measuring and data collection and evaluation devices for installations as defined within the meaning of the 30th Federal Immission Control Ordinance

The evaluation is outlined in Figure Figure G1.

B 1 Input materials, Exhaust gas cleaning

(§ 10 (2) and § 13 (2) and (3) of the 30th Federal Immission Control Ordinance)

49. The mass of the input materials in the delivery state shall be recorded on a daily basis.

50. Downtimes of the exhaust gas cleaning device shall be recorded in accordance with 43..

A 1 Formation and classification of mean values and other values

(§ 9, § 10 and § 13 of the 30th Federal Immission Control Ordinance)

The formation of the half-hourly mean values to be classified is to be carried out in accordance with Annex 24.1.1.1B 1.

A 1.1 Half-hour mean values for dust, total C, nitrous oxide and volume flow

A 1.1.1 The valid half-hour mean values for dust and total C are classified according to 43.1.1.1A 1.1.3.

A 1.1.2 The valid half-hour mean values for nitrous oxide and volume flow shall be classified in 20 classes of the same width for values up to the end of the measuring range (analogue Annex 7.). The end of the measuring range is on the upper class limit of class M20.

A 1.1.3 In addition to the special classes in Annex 24.1.1.1B 3, the following special classes are introduced (see 48.1.1.1B 1):

S12 current ARE failure

S15 dust in case of ARE failure $\leq$ 100 mg/m^3

S16 dust in case of ARE failure > 100 mg/m^3

The special classes S9 and S10 are eliminated for the volume flow.

A 1.2 **Daily mean values for dust and total C**

A 1.2.1 The daily mean values are classified in accordance with Annex 26..

A 1.2.2 Optionally, it should be possible to classify the daily mean values for nitrous oxide into classes T1-T10 (analogue Annex 22.). The measuring range end value is then on the upper class limit of class T10. The TS1 class is omitted. Invalid daily mean values shall be recorded in accordance with Annex 23..

A 1.3 **Further values to be formed**

(§ 10 (2) of 30. Federal Immission Control Ordinance)

A 1.3.1 For total C and nitrous oxide, the daily masses (TM) shall be formed from the respective daily mean values and the amount of exhaust gas (daily sum); please note 2.3.2.5.

A 1.3.2 The cumulative monthly masses (MM) are to be formed daily by summing up the daily masses of total C, of nitrous oxide and the substances used in accordance with 49..

A 1.3.3 The mass ratio (MMV) of total C and input materials as well as of nitrous oxide and input materials (each in g/Mg) are to be formed from the monthly masses.

A 2 Data Output

51. The daily data output shall also include the following data:

- Daily masses of total C and nitrous oxide as well as the input materials according to 50.1.1.1A 1.3.1
- current (cumulative) monthly mass of total C and nitrous oxide as well as the input materials according to 50.1.1.1A 1.3.2
- Current mass ratio of total C / input materials and nitrous oxide / input materials according to 50.1.1.1A 1.3.3

In addition to the event messages according to Annex 18. or 24., the following event messages are to be triggered:

- for special class S11 (if meter reading ≥ 193):

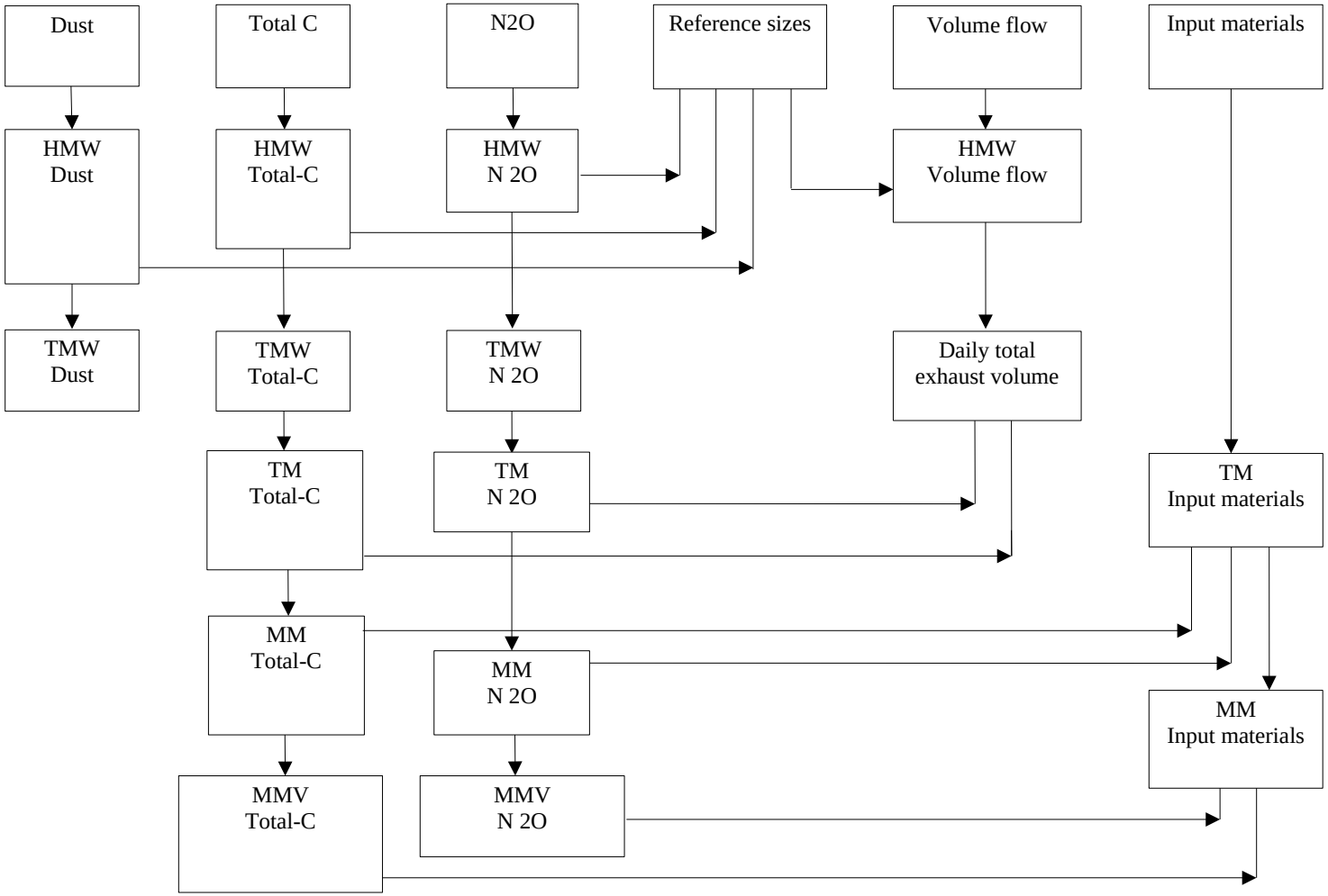
“ARE failure > 96 h” (output once)

- Special class S12 (if ≥ 17 entries in a row):
  “ARE failure > 8 h”

For special class S12, the meter reading < 17 is not reported. In the case of special class S15, there is no event reporting.

52. The data output at the end of the month or year should make it possible to also output the mass ratios of total C/components and of nitrous oxide/components of the previous months of the year.

Figure G1 Evaluation 30th Federal Immission Control Ordinance



Annex H

A Requirements for measuring and data collection and evaluation devices for plants within the meaning of the 2nd and 31st Federal Immission Control Ordinances

(§ 12 (9) and (10) in conjunction with § 4(2) of the 2nd Federal Immission Control Ordinance; Annex VI, number 2 in conjunction with § 5(5) and § 6 of the 31st Federal Immission Control Ordinance)

The requirements set out in Annex 24.1.1.1B shall apply with the following conditions:

- The averaging time for the short-term mean value is one hour.
- The limit value for the hourly mean value is equal to one and a half times the daily mean limit value.
- In the hourly mean values, the special class S3 is not used.

Annex I

B Requirements for measuring and data collection and evaluation devices for installations as defined within the meaning of the 44th Federal Immission Control Ordinance

B 1 Formation and classification of mean values

(§ 30 (1) in conjunction with § 29(3) and (8), § 21(2) and (3) and § 23(8) of the 44th Federal Immission Control Ordinance)

B 1.1 The formation of the mean values to be classified shall be carried out in accordance with Annex 24.1.1.1B 1.

B 1.2 The short-term mean values are classified in the same way as in Annexes 24.1.1.1B 2 and 24.1.1.1B 3.

B 1.3 The daily mean values are classified analogously according to Annex 24.1.1.1B 4 (see Figure D 1).

In addition to the TS1 and TS2 classes, the following classes are introduced:

TS3: daily mean values on which the measuring device was not in operation for more than six half-hour mean values due to malfunction or maintenance (availability not met, see).

Note: class TS3 is omitted when classifying the soot level.

B 1.4 Annex 48.1.1.1A 1.3 applies analogously to the evaluation of qualitative continuous measurements of total dust.

B 2 Start-up/shutdown times

(§ 30 (1) of the 44th Federal Immission Control Ordinance)

B 2.1 Approach/departure times in which twice the emission limit value is exceeded for technical reasons must be classified according to Annex 24.1.1.1B 3.

B 3 Exhaust gas purification

(§ 20 (3) and (4) of the 44th Federal Immission Control Ordinance)

B 3.1 Downtimes of the emission control system are to be classified according to Annex 30..

B 4 Data storage

(§ 7, (2) of the 44th Federal Immission Control Ordinance)

The data collection and evaluation device shall be able to store data in the permanent repository for at least six years.

B 5 Data Output

53. In addition to the event messages according to Annex 18. or 24., the following event messages are to be given:

- Special class S12 (if ≥ 49 entries in a row):
  “ARE failure > 24 h” with counter output
- Special class S13 (if meter reading ≥ 801):
  “ARE failure > 400 h” (output once per day)

If the meter reading is < 49 for special class S12 and < 801 for special class S13, there is no event message.