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ENVIRONMENTAL PROTECTION STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

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Specifications for continuous emissions monitoring of SO₂, NO_x, and particulate matter in the flue gas emitted from stationary sources

固定污染源烟气（SO₂、NO_x、颗粒物）排放连续监测技术规范

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Specifications for continuous emissions monitoring of SO₂, NO_x, and particulate matter in the flue gas emitted from stationary sources

1 Scope

This standard specifies the composition and functions, technical performance, monitoring station, installation, technical index commissioning and testing, technical acceptance, daily operation management, daily operation quality assurance, data review and processing requirements of the continuous monitoring system for flue gas emissions from stationary pollution sources, including gaseous pollutants (SO₂, NO_x), particulate matter emissions, as well as related flue gas parameters (oxygen content, etc.).

This standard applies to the continuous monitoring system for flue gas (SO₂, NO_x, particulate matter) emissions from stationary pollution sources such as thermal power plant boilers, industrial/civilian boilers, industrial furnaces that use solid or liquid as fuel or raw materials.

The continuous monitoring system for flue gas (SO₂, NO_x, particulate matter) emissions from domestic waste incinerators, hazardous waste incinerators, stationary pollution sources, that use gas as fuel or raw materials, can refer to this standard for implementation.

Before the corresponding standards for continuous monitoring systems for flue gas pollutant emissions are officially promulgated and implemented, they can refer to this standard for implementation.

2 Normative references

The content of this standard refers to the following documents or clauses therein. For any undated referenced documents, the latest version shall apply to this standard.

GB 4208 Degrees of protection provided by enclosure (IP code)

GB 50057 Code for design protection of structures against lightning

GB 50093 Code for construction and quality acceptance of automation instrumentation engineering

sources and upstream of the comparison monitoring section;

7.1.1.2 Not affected by ambient light and electromagnetic radiation;

7.1.1.3 The vibration amplitude of the flue shall be as small as possible;

7.1.1.4 The installation location shall avoid the interference of water droplets and water mist in the flue gas as much as possible. If it cannot be avoided, suitable detection probes and instruments shall be selected;

7.1.1.5 The installation location shall not leak air;

7.1.1.6 A waterproof low-voltage distribution box shall be set up in the working area where CEMS is installed, with a leakage protector and no less than two 10 A sockets to ensure the power required by the monitoring equipment;

7.1.1.7 The sampling platform and sampling holes shall be arranged reasonably;

- a) The length of the sampling or monitoring platform shall be ≥ 2 m; the width shall be ≥ 2 m or not less than 1 m outside the length of the sampling probe. The area above 1.2 m around shall be provided with safety guardrails, with firm and required safety measures to facilitate daily maintenance (cleaning optical lenses, checking and adjusting optical path alignment, testing instrument performance and replacing parts, etc.) and comparative monitoring.
- b) The sampling or monitoring platform shall be easy for personnel and monitoring instruments to reach. When the sampling platform is set at a height of ≥ 2 m from the ground, there shall be an inclined ladder (or Z-shaped ladder, spiral ladder) leading to the platform; the width shall be ≥ 0.9 m. When the sampling platform is set at a height of ≥ 20 m from the ground, there shall be an elevator leading to the platform.
- c) When CEMS is installed in a rectangular flue, if the height of the flue section is > 4 m, it should not open a reference method sampling hole on the top floor of the flue; if the width of the flue section is > 4 m, reference method sampling holes shall be opened on both sides of the flue, a multi-layer sampling platform shall be set up.
- d) Reference method sampling holes shall be reserved downstream of the CEMS monitoring section; the location and number of sampling holes shall be determined in accordance with the requirements of GB/T 16157. The inner diameter of the sampling hole for the reference method of the existing pollution source shall be ≥ 80 mm; the inner diameter of the sampling hole for the reference method of the new or rebuilt pollution source shall be ≥ 90 mm. Under the premise of not affecting the measurement, the sampling hole for the reference method shall be as close as possible to the CEMS monitoring section. When the flue is a positive pressure flue or there is toxic gas, a sealed sampling hole with a gate

performance of CEMS; prepare relevant documents such as construction plan, construction technical flow chart, equipment technical documents, design drawings, monitoring equipment and accessories goods list handover details, construction safety details, etc.

7.2.3 The equipment technical documents shall include a list of materials, product certificates, technical specifications for mechanical structure, electrical and instrument installation, packing lists, accessories, inspection certificates for purchased parts, instructions for use, etc.

7.2.4 The design drawings shall comply with the provisions of technical drawings, mechanical drawings, electrical drawings, building structure drawings and other standards.

7.2.5 The cleaning, inspection, maintenance of the equipment before installation shall meet the following requirements.

- a) Check the equipment and parts according to the delivery list and installation drawing list. The defective parts shall be handled and replaced in time.
- b) The sliding parts of the running parts such as sampling pumps, compressors, monitoring instruments, etc. shall be cleaned, lubricated, protected.
- c) The structural parts of the instruments and equipment that are deformed due to transportation shall be corrected; the anti-rust paint and surface paint shall be repainted. The original markings shall be restored after maintenance.

7.2.6 When the field connection materials (gaskets, nuts, bolts, short pipes, flanges, etc.) are paired and welded together, the misalignment of the wall (plate) shall meet the following requirements:

- a) The pipe or pipe fitting is aligned and the inner wall is flush, with a maximum misalignment of ≥ 1 mm;
- b) The geometric dimension limit deviation of the flange of the sampling hole and the connecting flange shall not exceed ± 5 mm; the perpendicularity limit deviation of the flange end face shall be $\leq 0.2\%$;
- c) For the particle monitoring instrument emission unit and particle monitoring instrument reflection unit using the transmission method principle, the measurement light beam from the center of the emission hole to the center line of the opposite side overlap limit deviation is $\leq 0.2\%$.

7.2.7 The laying of the entire sampling pipeline from the probe to the analyzer shall adopt a bridge or pipe penetration method, to ensure that the entire pipeline has good support. The pipeline inclination is $\geq 5^\circ$ to prevent water accumulation in the pipeline; a wire clamp is installed every 4 ~ 5 m. When using a heat tracing pipeline, it shall have

the function of stable and uniform heating and heat preservation; the set heating temperature shall be $\geq 120\text{ }^{\circ}\text{C}$; it shall be higher than the flue gas dew point temperature by more than $10\text{ }^{\circ}\text{C}$; its actual temperature value shall be able to be displayed in the cabinet or system software.

7.2.8 The installation of the cable tray shall meet the minimum bending radius requirements of the cable with the largest diameter. The connection of the cable tray shall use a connecting piece. The distribution bushing shall use steel pipe and PVC pipe material distribution pipe; its bending radius shall meet the minimum bending radius requirements.

7.2.9 Power and signal cables shall be laid separately, to ensure the sealing of the cable passage and cable protection pipe. The automatic control cable shall meet the wiring and laying requirements of input and output separation, digital signal and analog signal separation.

7.2.10 The installation accuracy and coordinate dimensions of the connection components shall comply with the provisions of the technical documents and drawings. The instruments in the monitoring station room shall be arranged neatly; the straightness and flatness of the top of the monitoring instrument shall not exceed 5 mm ; the monitoring instrument shall be firmly fixed and reliably grounded. The secondary wiring is correct, firm, reliable; the end of the distribution wire shall be marked with the circuit number. The wiring process is neat; the binding is firm; the insulation is good.

7.2.11 All connecting pipelines, flanges, valve sealing gaskets shall be firm and complete; there shall be no air or water leakage. Keep all pipelines unobstructed; ensure that the gas valves and drainage systems are unobstructed and flexible to open and close after installation. After the automatic monitoring system runs at no load for 24 hours, the pipelines shall not fall off, leak, or vibrate strongly.

7.2.12 The backwash gas shall be dry and clean gas; the backwash system shall be subjected to a pressure resistance strength test with a test pressure of 1.5 times the normal working pressure.

7.2.13 The shell protection of electrical control and electrical load equipment shall comply with the technical requirements of GB 4208, reaching the degree of protection IP24 indoors and IP54 outdoors.

7.2.14 Lightning protection and insulation requirements

- a) The working power supply of the system instruments and equipment shall have good grounding measures. The grounding cable shall use a single-core sheathed cable greater than 4 mm^2 , with a grounding resistance of less than $4\text{ }\Omega$; it cannot be shared with the lightning protection grounding wire.
- b) The lightning protection grounding of the platform, monitoring station, AC power equipment, cabinet, instrument and equipment metal shell, cable shielding layer

9 Technical acceptance of continuous monitoring system for flue gas emissions from stationary pollution sources

9.1 General requirements

After the installation, performance testing of CEMS are completed and the network is connected to the competent department, technical acceptance shall be carried out, including CEMS technical indicator acceptance and network acceptance.

9.2 Technical acceptance conditions

After the installation, performance testing of CEMS are completed and the following requirements are met, technical acceptance work can be organized and implemented.

- a) The installation location and manual sampling location of CEMS shall meet the requirements of Chapter 7 of this standard.
- b) Data collection and transmission as well as communication protocols shall meet the requirements of HJ/T 212; a self-inspection report on data collection and transmission within one month shall be provided. The report shall respond to the various contents of the data transmission standard.
- c) According to the requirements of Chapter 8 of this standard, a 72-hour commissioning test is carried out; a qualified commissioning test report and commissioning test result data are provided.
- d) After commissioning and testing, the system shall run stably for at least 7 days.

9.3 Acceptance of CEMS technical indicators

9.3.1 General requirements

9.3.1.1 The acceptance of CEMS technical indicators includes the acceptance of particulate matter CEMS, gaseous pollutant CEMS, flue gas parameter CMS technical indicators.

9.3.1.2 The acceptance time shall be determined by negotiation between the pollutant discharge organization and the acceptance organization.

9.3.1.3 During the on-site acceptance, the production equipment shall operate normally and stably; a certain emission condition can be achieved by adjusting the stationary pollution source flue gas purification equipment, which shall remain stable during the test.

9.3.1.4 When replacing the CEMS analyzer or changing the CEMS sampling point during daily operation, the requirements of 7.1 and 7.2 shall be met respectively; re-

acceptance shall be carried out.

9.3.1.5 Certified standard materials or standard samples must be used for on-site acceptance. Standard gases with lower concentrations can be obtained by using high-concentration standard gases by proportional dilution method. The precision of the proportional dilution device is within 1%. Standard gases are required to be stored in aluminum or stainless steel bottles with an uncertainty of no more than $\pm 2\%$.

9.3.1.6 For optical particulate matter CEMS, the actual measurement optical path must be calibrated during calibration, to ensure that the emitted light first passes through the exit lens, then through the actual measurement optical path, to the calibration lens, then through the incident lens to reach the receiving unit. It shall not calibrate only the laser transmitter and receiver. For extractive gaseous pollutant CEMS, when the whole system is subject to zero calibration and span calibration, detection of indication error and system response time, zero gas and standard gas shall be delivered to the sampling probe through the preset pipeline, returned to the station house through the sample transmission pipeline, entered the gas analyzer after passing through a full set of pretreatment facilities.

9.3.1.7 Before acceptance, check the setting of the direct extraction gaseous pollutant sampling heating pipe, which shall comply with the provisions of 7.2.7. The setting and actual control temperature of the cold dry CEMS condenser shall be maintained at $2 \sim 6\text{ }^{\circ}\text{C}$.

9.3.2 Acceptance of particle CEMS technical indicators

9.3.2.1 Acceptance content

The acceptance of particle CEMS technical indicators includes the acceptance of particle zero drift, span drift, accuracy.

9.3.2.2 Zero drift and span drift of particle CEMS

At the beginning of acceptance, manually or automatically calibrate the instrument zero and range; measure and record the initial zero and range readings; wait until the particle CEMS accuracy acceptance is completed; at least 6 hours after the initial zero and range measurement, measure (manually or automatically) and record the zero and range readings again; then calibrate the zero and range. Calculate the zero drift and span drift according to formula (A1) ~ formula (A4) in Appendix A.

9.3.2.3 Accuracy of CEMS for particulate matter

Use the reference method to measure the average concentration of particulate matter in the flue gas of the test section synchronously with CEMS; obtain at least 5 pairs of measurement results in the same time interval and the same state; calculate the accuracy of CEMS for particulate matter according to the following method:

- 2) Introduce high-concentration (80% ~ 100% of the full scale value) standard gas; adjust the instrument display concentration value to be consistent with the standard gas concentration value.
- 3) After the instrument is calibrated as above, the standard gas shall be introduced in the order of zero gas, high-concentration standard gas, zero gas, medium-concentration (50% ~ 60% of the full scale value) standard gas, zero gas, low-concentration (20% ~ 30% of the full scale value) standard gas. If the concentration of the low-concentration standard gas is higher than the emission limit, it is necessary to introduce standard gas with a concentration lower than the emission limit. After the ultra-low emission transformation is completed, the thermal power pollution source shall also introduce standard gas with a concentration lower than the ultra-low emission level. Read the measurement result after the displayed concentration value stabilizes. Repeat the measurement 3 times and take the average value. Calculate the indication error according to formulas (A19) and (A20) in Appendix A.

b) System response time:

- 1) After the CEMS to be tested is running stably, introduce zero point gas according to the system set sampling flow rate. After the reading is stable, introduce the range calibration gas at the same flow rate and start timing with a stopwatch;
- 2) Observe the analyzer indication until the reading begins to jump; record and calculate the sample gas pipeline transmission time T_1 ;
- 3) Continue to observe and record the instrument response time T_2 when the display value of the analyzer to be tested rises to 90% of the nominal value of the standard gas concentration;
- 4) The system response time is the sum of T_1 and T_2 . Repeat the measurement 3 times and take the average value.

9.3.3.3 Zero drift and span drift of CEMS for gaseous pollutants and CMS for oxygen

a) Zero drift:

Introduce zero gas (clean dry air or high-purity nitrogen that has been filtered and does not contain particulate matter or the gas to be tested) into the system; calibrate the instrument to zero; test and record the initial reading Z_0 . After the accuracy acceptance of gaseous pollutants and oxygen is completed and at least 6 hours after the initial test, introduce zero gas again; record the zero reading Z_1 after the reading stabilizes. Calculate zero drift Z_d according to formulas (A1) and (A2) in Appendix A.

ΔX_{SW} - Absolute error of flue gas humidity, %;

n - Number of measurements (≥ 5);

X_{SWCMS} - Average flue gas humidity measured by flue gas humidity CMS and reference method at the same time, %;

X_{SWi} - Average flue gas humidity measured by reference method, %;

R_{es} - Relative error of flue gas humidity, %

9.3.5 The acceptance test results can be recorded in the form of tables D.1, D.3 ~ D.5, D.8 in Appendix D.

9.3.6 Technical indicator acceptance test report format

The report shall include the following information (refer to Appendix F):

- a) Report identification-number;
- b) Testing date and report preparation date;
- c) CEMS identification-manufacturer, model and serial number;
- d) Name of the company installing the CEMS and the name of the relevant pollution source where the installation is located;
- e) Record of environmental conditions (atmospheric pressure, ambient temperature, ambient humidity);
- f) Standards cited for acceptance of indication error, system response time, zero drift, span drift;
- g) Standards cited for accuracy acceptance;
- h) Standard gases used that can be traced back to national standards;
- i) Main equipment and instruments used in the reference method;
- j) Testing results and conclusions;
- k) Test organization;
- l) Three-level audit signature;
- m) Remarks (other information that the technical acceptance organization considers relevant to the performance evaluation of the CEMS).

9.3.7 Technical requirements for acceptance of indication error, system response

standard substance or standard sample shall also be recorded. System management and maintenance personnel shall promptly handle and record any faults or problems found during routine inspections or maintenance.

CEMS daily operation management shall refer to the format in Appendix G for records.

10.4 Calibration and verification of CEMS

The daily calibration and verification operating procedures of the CEMS system shall be formulated according to the methods specified in this standard and the cycle specified in Chapter 11 Quality assurance. Calibration and verification records shall be filed in a timely manner.

11 Quality assurance requirements for daily operation of continuous monitoring systems for flue gas emissions from stationary pollution sources

11.1 General requirements

The quality assurance of daily operation of CEMS is a necessary means to ensure the normal and stable operation of CEMS and to continuously provide quality-assured monitoring data. When CEMS fails to meet technical indicators and is out of control, corrective measures shall be taken in a timely manner; the interval between the next calibration, maintenance and verification shall be shortened.

11.2 Regular calibration

The regular calibration during the operation of CEMS is an important task in quality assurance. Regular calibration shall be done as follows:

- a) For particulate matter CEMS and gaseous pollutant CEMS with automatic calibration function, the instrument zero point and span shall be automatically calibrated at least once every 24 hours; the zero drift and span drift shall be tested and recorded at the same time;
- b) For particulate matter CEMS without automatic calibration function, the instrument zero point and span shall be calibrated at least once every 15 days; the zero drift and span drift shall be tested and recorded at the same time;
- c) For direct measurement gaseous pollutant CEMS without automatic calibration function, the instrument zero point and span shall be calibrated at least once every 15 days; the zero drift and span drift shall be tested and recorded at the same time;
- d) For extractive gaseous pollutant CEMS without automatic calibration function,

the instrument zero point and span shall be calibrated at least once every 7 days; the zero drift and span drift shall be tested and recorded at the same time;

- e) For extractive gaseous pollutant CEMS, the whole system shall be calibrated at least once every 3 months. The zero gas and standard gas shall be emitted from the monitoring station room; the path through which the sample gas passes (including sampling pipeline, filter, scrubber, regulator, analytical instrument, etc.) at the end of the sampling probe shall be consistent with that of the sample gas. The zero point and span drift, indication error and system response time shall be detected.
- f) The flow rate CMS with automatic calibration function shall be calibrated at least once every 24 hours; the flow rate CMS without automatic calibration function shall be calibrated at least once every 30 days;
- g) The calibration technical indicators shall meet the requirements of Table 4. The regular calibration records shall be recorded in the form of Table G.4 in Appendix G.

11.3 Regular maintenance

The regular maintenance during the operation of CEMS is an important task of daily inspection. The maintenance frequency shall be carried out in accordance with the instructions in Table G.1 ~ Table G.3 of Appendix G. Regular maintenance shall be done as follows:

- a) The optical mirror shall be cleaned on site in time from the shutdown of the pollution source to the start of production;
- b) The glass window isolating the flue gas and the optical probe shall be cleaned regularly; the alignment of the instrument optical path shall be checked; the clean air protection device shall be maintained regularly; the air compressor or blower, hose, filter and other components shall be checked;
- c) The dust and condensation of the filter, sampling probe and pipeline of the gaseous pollutant CEMS, the aging of the gas cooling components, converter and pump membrane shall be checked regularly;
- d) The dust accumulation and corrosion of the flow rate probe shall be checked regularly; the working status of the backflush pump and pipeline shall be checked regularly;
- e) Regular maintenance records shall be recorded in the form of Tables G.1 ~ G.3 in Appendix G.

11.4 Periodic calibration

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