HJ

NATIONAL ENVIRONMENTAL PROTECTION

STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

HJ 654-2013

Specifications and test procedures for ambient air quality continuous automated monitoring system for SO_2, NO_2, O_3 and CO

环境空气气态污染物（SO_2、NO_2、O_3、CO）连续自动监测系统技术要求及检测方法

[Including 2018XG1]

Issued on: July 30, 2013 **Implemented on: August 1, 2013**

Issued by: Ministry of Environmental Protection

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Specifications and test procedures for ambient air quality continuous automated monitoring system for SO_2, NO_2, O_3 and CO

1 Scope of application

This Standard specifies the composition, specifications, test indicators and test procedures for ambient air quality continuous automated monitoring system for SO_2, NO_2, O_3 and CO.

This Standard is applicable to the design, production and testing of ambient air quality continuous automated monitoring system for SO_2, NO_2, O_3 and CO.

2 Normative references

This Standard refers to the terms in the following documents. For undated references, the latest editions apply to this Standard.

GB 3095-2012 *Ambient air quality standards*

GB 4793.1 *Safety requirements for electrical equipment for measurement, control, and laboratory use -- Part 1: General requirements (IEC 61010-1:2001, IDT)*

3 Terms and definitions

The following terms and definitions apply to this Standard.

3.1 Ambient air quality continuous monitoring

The process of continuous sample collection, processing and analysis of ambient air quality using a continuous monitoring instrument at monitoring points.

3.2 Point analyzer

A monitoring and analysis instrument that takes ambient air through a sampling system at a fixed point and determines the concentration of air pollutants.

3.3 Open path analyzer

An apparatus for determining the average concentration of air pollutants over the optical path of the beam by means of a method of emitting a beam of light from the transmitting end through an open environment to a receiving end.

3.4 Zero drift

The deviation between the reading of the instrument and the zero input after the instrument has been operated for a specified period of time without maintenance, care or adjustment.

3.5 Span drift

The deviation between the reading of the instrument and the known reference value after the instrument has been operated for a specified period of time without maintenance, care or adjustment.

3.6 Period of unattended operation

The time interval during which the instrument meets the requirements of the indicator for long-term drift (≥ 7d) without manual maintenance and calibration.

3.7 Converter efficiency

The efficiency of converting NO_2 to NO.

3.8 Standard state

The state when the temperature is 273K, and the pressure is 101.325kPa. The concentration of pollutants in this Standard is the concentration under standard state.

3.9 ppm parts per million

Millionth volume concentration.

3.10 ppb parts per billion

One billionth volume concentration.

3.11 Optical path

The path length of the monitoring beam of the open optical path analysis instrument from the transmitting end to the receiving end of the light source.

3.12 Zero optical path

The optical path of the light from the transmitting end to the receiving end of the light source in the calibration state of the open optical path analysis instrument, which is much smaller than the optical path of the actual measurement, is called

5 Specifications

5.1 Point continuous monitoring system

5.1.1 Appearance requirements

5.1.1.1 The monitoring system shall have a product nameplate indicated with the instrument name, model, production organization, factory number, date of manufacture, etc.

5.1.1.2 The surface of the monitoring system instrument shall be intact, with no obvious defects. The components shall be connected reliably, and the operation keys and buttons shall be flexible and valid.

5.1.1.3 The instrument main unit panel shall be clear in display, and easy to identify characters and identifications.

5.1.2 Operating conditions

The monitoring system shall function properly under the following conditions.

(1) Ambient temperature: (15 ~ 35) °C;
(2) Relative humidity: ≤ 85%;
(3) Atmospheric pressure: (80 ~ 106) kPa;
(4) Supply voltage: AC (220 ± 22) V, (50 ± 1) Hz.

NOTE 1: Under special environmental conditions such as low temperature and low pressure, the instruments and equipment shall be configured to meet the requirements of local environmental conditions.

5.1.3 Safety requirements

5.1.3.1 Insulation resistance

Under the conditions of ambient temperature of (15 ~ 35) °C, and relative humidity of ≤ 85%, the insulation resistance of the instrument power terminal to the ground or the casing shall not be less than 20MΩ.

5.1.3.2 Insulation strength

Under the conditions of ambient temperature of (15 ~ 35) °C, and relative humidity of ≤ 85%, the instrument will last for 1min under the 1500V (RMS value), 50Hz sine wave test voltage, and there shall be no breakdown or arcing.

5.1.4 Functional requirements

5.1.4.1 Sampling device

sampling manifold stably.

(3) The materials used for the sampling device shall be selected from materials that do not chemically react with the monitored pollutants and do not release interfering substances. Generally, it is made of polytetrafluoroethylene (PTFE) or borosilicate glass, etc. Stainless steel is also available for the sampling manifold used to monitor NO_2 and SO_2 only.

(4) The inner diameter of the sampling manifold is within the range of 1.5cm to 15cm. The airflow in the manifold shall be laminar. The residence time of the sample gas in the manifold shall be less than 20s. Meanwhile, the pressure of the collected gas sample shall be close to atmospheric pressure. The branch connector shall be placed in the laminar flow area of the sampling manifold. The distance between the branch connectors is greater than 8cm.

(5) In order to prevent condensation on the inner wall of the sampling manifold due to the difference in indoor and outdoor air temperatures, the sampling manifold shall be equipped with a thermal insulation sleeve or heater. The heating temperature is generally controlled at (30 to 50) °C.

(6) The pipeline connecting the analytical instrument to the branch connector shall be made of materials that do not chemically react with the monitored pollutants and do not release the interfering substances; the length shall not exceed 3m, and the air outlet of the air conditioner shall be prevented from being directly blown to the sampling manifold and the branch pipe.

(7) The pipeline connecting the analytical instrument to the branch connector shall be equipped with a PTFE membrane with a pore diameter of ≤ 5μm.

(8) The pipeline connecting the analytical instrument to the branch connector shall be extended to the position where the manifold is close to the center when connecting the manifold.

(9) When not using the sampling manifold, it can be sampled directly in the pipeline. However, the sampling pipeline shall use materials that do not chemically react with the monitored pollutants and do not release interfering substances. The time that the sample gas is trapped in the sampling pipeline shall be less than 20s.

5.1.4.2 Calibration device

(1) The calibration device of the monitoring system shall be capable of automatic calibration.

(2) The zero gas quality of the zero gas generator shall comply with the requirements of Annex A.

(3) Atmospheric pressure: (80 ~ 106) kPa.

5.2.2.3 Supply voltage

AC (220 ± 22) V, (50 ± 1) Hz.

NOTE 2: Under special environmental conditions such as low temperature and low pressure, the instruments and equipment shall be configured to meet the requirements of local environmental conditions.

5.2.3 Safety requirements

SEE 5.1.3 for safety requirements.

5.2.4 Functional requirements

5.2.4.1 Calibration unit

(1) The monitoring system shall be capable of automatically recording and measuring the light spectrum;

(2) The equivalent calibration device shall be equipped with at least 4 calibration cells of different lengths. The materials of the calibration cell shall be made of materials with high UV transmittance. The calibration frame and the light source emitting device shall be firmly connected.

5.2.4.2 Analytical instrument as well as data acquisition and transmission equipment

(1) Able to display and set the system time.

(2) Able to display the parameter information of the internal working status of the instrument, and record the working status information of the system at least every 5min.

(3) Able to display the real-time data as well as to record and store valid data for at least 3 months, along with the function of querying historical data.

(4) Have the time stamp function, and the data is the average of the set time period.

(5) Capable of digital signal output.

(6) Equipped with the Chinese data acquisition and control software.

(7) The monitoring data is collected, stored, and calculated in real time, and can be output in the form of a statement or a report. The mass concentration unit in the output standard state is μg/m^3, and has a mass concentration and volume concentration unit switching function.

80% span precision of CO analytical instrument: ≤ 0.5 ppm.

6.1.1.7 24h zero drift

24h zero drift of SO_2, NO_2, and O_3 analytical instruments: ± 5 ppb;

24h zero drift of CO analytical instrument: ± 1 ppm.

6.1.1.8 24h span drift

24h 20% span drift of SO_2, NO_2, and O_3 analytical instruments: ± 5 ppb;

24h 80% span drift of SO_2, NO_2, and O_3 analytical instruments: ± 10 ppb;

24h 20% span drift of CO analytical instrument: ± 1 ppm;

24h 80% span drift of CO analytical instrument: ± 1 ppm.

6.1.1.9 Response time (rise time / fall time)

Response time (rise time / fall time) of SO_2, NO_2, and O_3 analytical instruments: ≤ 5min;

Response time (rise time / fall time) of CO analytical instrument: ≤ 4min.

6.1.1.10 Voltage stability

The supply voltage varies by ±10%, and the change in the analytical instrument reading: ±1% of full scale.

6.1.1.11 Flow stability

Flow stability: ± 10%.

6.1.1.12 Effect of changes in ambient temperature

Within the ambient temperature range of 15~35°C:

Effect of changes in temperature of SO_2 analytical instrument is ≤ 1 ppb/°C;

Effect of changes in temperature of NO_2 analytical instrument is ≤ 3 ppb/°C;

Effect of changes in temperature of O_3 analytical instrument is ≤ 1 ppb/°C;

Effect of changes in temperature of CO analytical instrument is ≤ 0.3 ppm/°C.

6.1.1.13 Effect of interference components

The influence indicators of the analytical instrument's interference components are shown in Table 2.

(2) Flow linearity error: ±1%;

(3) Ozone generation concentration error: ± 2%.

6.2 Open optical path continuous monitoring system

6.2.1 Measurement range

Measurement range of SO_2, NO_2, and O_3 analytical instruments: (0 ~ 500) ppb, and the minimum display unit is 0.1ppb or 0.1μg/m^3.

6.2.2 Zero noise

Zero noise of SO_2, NO_2, and O_3 analytical instruments: ≤ 1 ppb.

6.2.3 Minimum detection limit

Minimum detection limit of SO_2, NO_2, and O_3 analytical instruments: ≤ 2 ppb.

6.2.4 Span noise

80% span noise of SO_2, NO_2, and O_3 analytical instruments: ≤ 5 ppb.

6.2.5 Indication error

Indication error of SO_2, and NO_2 analytical instruments: ±2% of full scale;

Indication error of O_3 analytical instrument: ±4% of full scale.

6.2.6 Span precision

20% span precision of SO_2, NO_2, and O_3 analytical instruments: ≤ 5 ppb;

80% span precision of SO_2, NO_2, and O_3 analytical instruments: ≤ 10 ppb.

6.2.7 24h zero drift

24h zero drift of SO_2, NO_2, and O_3 analytical instruments: ± 5 ppb.

6.2.8 24h span drift

24h 20% span drift of SO_2, NO_2, and O_3 analytical instruments: ± 5 ppb;

24h 80% span drift of SO_2, NO_2, and O_3 analytical instruments: ± 10 ppb.

6.2.9 Response time (rise time / fall time)

Response time (rise time / fall time) of SO_2, NO_2, and O_3 analytical instruments: ≤ 5min.

$$USD_n = M_{80n} - M_{80(n-1)} \quad (9)$$

Where:

USD_n - The n^{th} 24h 80% span drift of the analytical instrument to be tested, ppb (ppm);

M_{80n} - The n^{th} 80% span standard-gas measured value of the analytical instrument to be tested, ppb (ppm).

7.1.7 Response time (rise time / fall time)

After the analytical instrument to be tested is running stably, the zero standard-gas is introduced. After the reading is stable, 80% span standard-gas is introduced and a chronograph is used to start timing. When the value displayed on the analytical instrument to be tested rises to 90% of the nominal value of the standard-gas concentration, the timing is stopped. The time taken for recording is the rise time of the analytical instrument to be tested. After the measurement reading of 80% span standard-gas is stable, the zero standard-gas is introduced and a chronograph is used to start timing. The timing is stopped when the value displayed on the analytical instrument to be tested drops to 10% of the nominal value of 80% span standard-gas concentration. The time taken for recording is the fall time of the analytical instrument to be tested.

The response time is tested once a day and the test is repeated for 3d. The average shall meet the requirements of 6.1.1.9.

7.1.8 Voltage stability

After the analytical instrument to be tested is running stably, 80% span standard-gas is injected under normal voltage conditions, and the reading W of the analytical instrument to be tested is recorded after stabilization. ADJUST the supply voltage of the analytical instrument to be tested to be higher than the normal voltage value by 10%, INJECT the same concentration of standard-gas, and RECORD the reading X of the analytical instrument to be tested after stabilization. ADJUST the supply voltage of the analytical instrument to be tested to be lower than the normal voltage value by 10%, INJECT the same concentration of standard-gas, and RECORD the reading Y of the analytical instrument to be tested after stabilization. CALCULATE the voltage stability V of the analytical instrument to be tested according to Formula (10), which shall meet the requirements of 6.1.1.10.

$$V = \frac{X - W}{R} \times 100\% \quad \text{or} \quad \frac{Y - W}{R} \times 100\% \quad (10)$$

M_3 - 80% span standard-gas measured value of the analytical instrument to be tested at an ambient temperature of t_3, ppb (ppm);

M_4 - 80% span standard-gas measured value of the analytical instrument to be tested at an ambient temperature of t_4, ppb (ppm);

Z_0 - Zero standard-gas measured value of the analytical instrument to be tested at an ambient temperature of t_0, ppb (ppm);

Z_1 - Zero standard-gas measured value of the analytical instrument to be tested at an ambient temperature of t_1, ppb (ppm);

Z_2 - Zero standard-gas measured value of the analytical instrument to be tested at an ambient temperature of t_2, ppb (ppm);

Z_3 - Zero standard-gas measured value of the analytical instrument to be tested at an ambient temperature of t_3, ppb (ppm);

Z_4 - Zero standard-gas measured value of the analytical instrument to be tested at an ambient temperature of t_4, ppb (ppm);

t_0 - Standard temperature value when the temperature is set to (25±1) °C for the first time in a constant temperature environment, °C;

t_1 - Standard temperature value when the temperature is set to (35±1) °C in a constant temperature environment, °C;

t_2 - Standard temperature value when the temperature is set to (25±1) °C for the second time in a constant temperature environment, °C;

t_3 - Standard temperature value when the temperature is set to (15±1) °C in a constant temperature environment, °C;

t_4 - Standard temperature value when the temperature is set to (25±1) °C for the third time in a constant temperature environment, °C.

7.1.11 Effect of interference components

SEE Table 2 for interference gases. After the analytical instrument to be tested is running stably, INJECT the zero standard-gas, and RECORD the reading a of the analytical instrument to be tested; RECORD the interference gas of the specified concentration, and RECORD the reading b of the analytical instrument to be tested. Each interference gas is repeatedly tested three times according to the above operation, and the averages $\bar{a}$ and $\bar{b}$ are calculated. CALCULATE the effect IE of the interference components of the analytical instrument to be tested according to Formula (13), which shall meet the requirements of 6.1.1.13.

accuracy of the permeation chamber is ±0.1°C) is used to generate (20% to 60%) span standard-gas and inject into the analytical instrument to be tested. The display value C_{NO2} is recorded after the reading is stable. REPEAT the test 3 times. CALCULATE the average $\overline{C_{NO2}}$. CALCULATE the conversion efficiency η of the analytical instrument to be tested according to Formula (15), which shall meet the requirements of 6.1.1.15.

$$\eta = \frac{\overline{C_{NO2}}}{C_0} \times 100\% \quad \text{.....(15)}$$

Where:

η - Conversion efficiency of the analytical instrument to be tested, %;

$\overline{C_{NO2}}$ - Average of 3 measurements of NO_2 standard-gas, ppb;

C_0 - Concentration value of NO_2 standard-gas, ppb.

(2) After the analytical instrument to be tested is running stably, INJECT the (20% to 60%) span NO_2 standard-gas. The display value C_{NO2} of the analytical instrument to be tested is recorded after the reading is stable. REPEAT the test 3 times. CALCULATE the average $\overline{C_{NO2}}$. CALCULATE the conversion efficiency η of the analytical instrument to be tested according to Formula (15), which shall meet the requirements of 6.1.1.15.

(3) The operation procedures in the testing process are as follows:

a) After the analytical instrument to be tested is running stably, INJECT 80% span NO standard-gas, and RECORD the NO and NO_X stable readings of the analytical instrument to be tested, respectively. REPEAT the operation 3 times, and CALCULATE the averages of the NO and NO_X readings, $[NO]_{orig}$ and $[NO_X]_{orig}$.

b) START the ozone generator in the calibration device of the monitoring system to generate a certain concentration of ozone. Under the same experimental conditions, INJECT the same concentration of NO standard-gas as in a), and the NO and NO_X stable readings of the analytical instruments to be tested are recorded separately. REPEAT the operation 3 times, and CALCULATE the averages of the NO and NO_X readings, $[NO]_{rem}$ and $[NO_X]_{rem}$.

The standard concentration value of the generated NO_2 gas, $[NO_2]_{standard}$,

state. SEE 7.1.2 for the test method. The minimum detection limit of the analytical instrument to be tested shall meet the requirements of 6.2.3.

7.2.3 Span noise

The analytical instrument to be tested is in a zero optical path measurement state. SEE 7.1.3 for the test method. The span noise of the analytical instrument to be tested shall meet the requirements of 6.2.4.

7.2.4 Indication error

The analytical instrument to be tested is in a zero optical path measurement state. SEE 7.1.4 for the test method. The indication error of the analytical instrument to be tested shall meet the requirements of 6.2.5.

7.2.5 Span precision

The analytical instrument to be tested is in a zero optical path measurement state. SEE 7.1.5 for the test method. The span precision of the analytical instrument to be tested shall meet the requirements of 6.2.6.

7.2.6 24h zero drift and 24h span drift

The analytical instrument to be tested is in a zero optical path measurement state. SEE 7.1.6 for the test method. The 24h zero drift of the analytical instrument to be tested shall meet the requirements of 6.2.7; and 24h span drift shall meet the requirements of 6.2.8.

7.2.7 Response time (rise time / fall time)

When the analytical instrument to be tested is in the zero optical path measurement state, the 80% span standard-gas at a concentration of about 80% is injected into the calibration cell. After stabilization, the calibration cell is placed in the instrument optical path and a chronograph is used to start timing. When the value displayed on the analytical instrument to be tested rises to 90% of the nominal value of the standard-gas concentration, the timing is stopped. The time taken for recording is the rise time of the analytical instrument to be tested. After the measurement reading of 80% span standard-gas is stable, the calibration cell is removed rapidly and a chronograph is used to start timing. The timing is stopped when the value displayed on the analytical instrument to be tested drops to 10% of the nominal value of 80% span standard-gas concentration. The time taken for recording is the fall time of the analytical instrument to be tested.

The response time is tested once a day and the test is repeated for 3d. The average shall meet the requirements of 6.2.9.

		the data is the measured average from 1 to 24 o'clock on the day (0 o'clock on the next day).	01:00 on March 21 and 00:00 on March 22, 2012

B.2 Data recording requirements

B.2.1 The monitoring system shall at least display real-time data such as the mass concentration, volume concentration, and sampling flow of the recorded gaseous pollutants.

B.2.2 The hourly data shall record at least the average of the mass concentration and volume concentration of gaseous pollutants during that time period.

B.2.3 The minute data shall record at least the average of the mass concentration and volume concentration of gaseous pollutants during that time period.

B.2.4 The maximum, minimum, and daily average values of the hourly data for the day shall be recorded.

B.3 Data processing requirements

B.3.1 The hourly data of the mass concentration of gaseous pollutants is calculated according to Formula (B1):

$$C_i = \frac{\sum_{j=1}^{k} m_{ij}}{k} \quad \text{(B1)}$$

Where:

C_i - Mass concentration of gaseous pollutants at the i^{th} hour of the monitoring system, μg/m^3 (mg/m^3);

m_{ij} - Mass concentration of gaseous pollutants at the i^{th} hour, j^{th} minute of the monitoring system, μg/m^3 (mg/m^3);

k - Number of minutes effectively measured during the hour in the monitoring system ($45 \leq k \leq 60$).

B.3.2 The daily average data of the mass concentration of gaseous pollutants is calculated according to Formula (B2):

$$\overline{C_m} = \frac{\sum_{i=1}^{n} C_{m,\,i}}{n} \quad \text{(B2)}$$

Where:

$\overline{C_m}$ - Daily average of the mass concentration of gaseous pollutants on the m^{th} day of the monitoring system, μg/m³ (mg/m³);

$C_{m,\,i}$ - Mass concentration of gaseous pollutants at the i^{th} hour on the m^{th} day of the monitoring system, μg/m³ (mg/m³);

n - Number of minutes effectively measured during the day in the monitoring system ($20 \le n \le 24$).

B.3.3 Conversion of volume concentration and mass concentration units of gaseous pollutants

$$C_Q = \frac{M}{22.4} \times C_V \quad \text{(B3)}$$

Where:

C_Q - Mass concentration of pollutants, μg/m³ (mg/m³);

M - Molar mass of pollutants, g/mol;

C_V - Volume concentration of pollutants, ppb (ppm).

B.3.4 NO_X unit conversion

The nitrogen oxides are calculated as NO_2, and the mass concentration of nitrogen oxides can be calculated according to the Formula (B4) or (B5).

$$C_{NO_x} = C_{NO} \times \frac{M_{NO2}}{M_{NO}} + C_{NO2} \quad \text{(B4)}$$

Where:

C_{NOx} - Mass concentration of nitrogen oxides, μg/m³;

C_{NO} - Mass concentration of NO, μg/m³;

C_{NO2} - Mass concentration of NO_2, μg/m³;

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