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HJ

Environmental Protection Standard of the People's Republic of China

HJ 653-2013

Specifications and Test Procedures for Ambient Air Quality Continuous Automated Monitoring System for PM_{10} and $PM_{2.5}$

环境空气颗粒物（PM_{10} and $PM_{2.5}$）连续自动检测系统技术要求及检测方法

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

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Ministry of Environmental Protection of the People's Republic of China

Announcement

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In order to enforce the *Environmental Protection Law of People's Republic of China*, protect the environment, protect human health, regulate the monitoring work on air quality, it is hereby approving the *Technical Specifications and Test Procedures for Ambient Air Particulate Matter (PM_{10} and $PM_{2.5}$) Continuous Automated Monitoring System* and other five standards as the national environmental standards, and hereby they are publish.

Standard name and standard number are as follows:

1. *The Technical Specifications and Test Procedures for Ambient Air Particulate Matter (PM_{10} and $PM_{2.5}$) Continuous Automated Monitoring System* (HJ 653-2013);
2. *The Technical Specifications and Test Procedures for Ambient Air Gaseous Pollutant (SO_2, NO_2, O_3, and CO) Continuous Automated Monitoring System* (HJ 654-2013);
3. *The Technical Specifications and Test Procedures for Ambient Air Particulate Matter (PM_{10} and $PM_{2.5}$) Continuous Automated Monitoring System* (HJ 93-2013);
4. *Specifications and Test Procedures for Ambient Air Particulate Matter (PM_{10} and $PM_{2.5}$) Continuous Automated Monitoring System* (HJ 655-2013);
5. *Specifications and Test Procedures for Ambient Air Gaseous Pollutant (SO_2, NO_2, O_3, and CO) Continuous Automated Monitoring System* (HJ 193-2013);
6. *The Technical Specifications of Ambient Air Particulate Matter ($PM_{2.5}$) Manual Monitoring Methods (Gravimetric Method)* (HJ 656-2013).

The above standards shall be implemented from August 1, 2013, and are published by the China Environmental Press. Contents of the standards content can be found at the website of the Ministry of Environmental Protection (bz.mep.gov.cn).

From the date of the implementation of the above standards, the following national environmental standards approved and published by former State Environmental Protection Administration shall be abolished, the standards' names and numbers are as follows:

1. *The Technical Specifications and Test Procedures for PM_{10} Sampler* (HJ/T 93-2003);
2. *Ambient Air Quality Automatic Monitoring Technical Specification* (HJ/T 193-2005).

Hereby it is announced.

Ministry of Environmental Protection

July 30, 2013

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Foreword

In order to enforce the *Environmental Protection Law of People's Republic of China*, *Air Pollution Prevention Law of People's Republic of China*, implement *Ambient Air Quality Standard* (GB 3095-2012), and regulate the performance and quality of the continuous automatic monitoring system on ambient air particulate matter (PM_{10} and $PM_{2.5}$), this Standard is formulated.

This Standard specifies the technical requirements, performance metrics and test methods of the continuous automatic monitoring system (hereinafter referred to as PM_{10} and $PM_{2.5}$ continuous monitoring system) on ambient air particulate matter (PM_{10} and $PM_{2.5}$).

Annex A of this Standard is the normative annex.

This Standard is first-time issued.

This Standard is organized and formulated by Department of Science & Technology and Standards, Ministry of Environmental Protection.

This Standard is mainly drafted by the following organization: China National Environmental Monitoring Center.

This Standard was approved by Ministry of Environmental Protection on July 30, 2013.

This Standard shall be implemented from August 1, 2013.

The Ministry of Environmental Protection of the People’s Republic of China is responsible for the interpretation of this Standard.

Specifications and Test Procedures for Ambient Air Quality Continuous Automated Monitoring System for PM_{10} and $PM_{2.5}$

1 Scope

This Standard specifies the technical requirements, performance metrics and test methods of the continuous automatic monitoring system on ambient air particulate matter (PM_{10} and $PM_{2.5}$).

This Standard is applicable for the design, production and detection of the continuous automatic monitoring system on ambient air particulate matter (PM_{10} and $PM_{2.5}$).

2 Normative References

The provisions contained in the following documents have become part of this Standard when they are quoted herein. For the undated documents so quoted, the latest editions shall be applicable to this Standard.

GB 3095-2012 Ambient air quality standard

GB/T 17214.1 Industrial-process measurement and control equipment -- Operating conditions Part 1: Climatic conditions

HJ 618 Determination of atmospheric articles PM_{10} and $PM_{2.5}$ in ambient air by gravimetric method

3 Terms and definitions

For the purpose of this standard, the following terms and definitions shall apply.

3.1 Aerodynamic diameter

It refers to the diameter of which the sphere with the unit density (ρ_0=1g/cm^3) reaches the final settling velocity as actual particle, when it travels with low Reynolds movement in still air.

3.2 Cutter

It refers to the device which has function of separating particles of different diameters.

3.3 50% cut particle-diameter

It refers to the equivalent aerodynamic particle diameter when the trapping efficiency of the cutter

[Translator: the device which cuts particle] to the particulate matter reaches 50%.

3.4 Particulate matter (diameter of particles ≤10μm) particulate-matter (PM_{10})

It refers to the particulate matter with the aerodynamic equivalent diameter in the ambient air less than or equal to 10μm, which is also known as inhalable particulate matter.

3.5 Particulate matter (diameter of particles ≤2.5μm) particulate-matter ($PM_{2.5}$)

It refers to the particulate matter with the aerodynamic equivalent diameter in the ambient air less than or equal to 2.5μm, which is also known as fine particulate matter.

3.6 Standard state

The state when the temperature is 273K and pressure is 101.325kPa. Pollutant concentration in this Standard refers to the concentration under this standard state.

3.7 Reference method

Standard methods issued by the State.

3.8 Geometric standard deviation of trapping efficiency (δ_g)

Trapping efficiency of cutter to particulate matter includes the following two statements:

(1) The ratio OF the corresponding particle aerodynamic equivalent diameter D_{a16} when the trapping efficiency is 16% WITH the corresponding particle aerodynamic equivalent diameter D_{a50} when the trapping efficiency is 50%;

(2) The ratio OF the corresponding particle aerodynamic equivalent diameter D_{a50} when the trapping efficiency is 50% WITH the corresponding particle aerodynamic equivalent diameter D_{a80} when the trapping efficiency is 80%.

Both of above two ratios shall meet the requirements of δ_g = 1.5 ± 0.1 (PM_{10}) continuous monitoring system), and δ_g = 1.2 ± 0.1 ($PM_{2.5}$ continuous monitoring system). Calculation refers to Formula (1) and (2).

$$\sigma_g = \frac{Da_{16}}{Da_{50}} \quad (1)$$

$$\sigma_g = \frac{Da_{50}}{Da_{84}} \quad (2)$$

Where: δ_g -- Geometric standard deviation of trapping efficiency, %;

D_{a16} -- The equivalent aerodynamic particle diameter when the trapping efficiency of the cutter to the particulate matter reaches 16%, μm;

D_{a50} -- The equivalent aerodynamic particle diameter when the trapping efficiency of the cutter to the particulate matter reaches 50%, μm;

shall meet the requirements of 6.1.2.

7.1.1.2 Static box test method

The tested cutter is mounted in a static box; GENERATE a single size, uniform and stable aerosol; USE the aerosol detecting instrument to measure the concentration and uniformity of the aerosol; ENSURE stable aerosol concentration and uniform distribution in the box. USE aerosol detecting instrument to measure aerosol concentration after being cut by cutter under test. Calculate the trapping efficiency of particles with different particle-diameters; MATCH the relation between the trapping efficiency and the particle-diameter to obtain the geometric standard deviation of the trapping efficiency and 50% cutting particle-diameter of the cutter.

(1) INSTALL the cutter under test. INSTALL at least one set of cutter under test into static box; ENSURE the box closed.

(2) The generation of aerosol. PRODUCE monodisperse solid aerosol particles by monodisperse solid aerosol generator. USE aerosol detection equipment (such as aerosol particle spectrometer) to measure the particle-diameter and concentration of monodisperse solid aerosols. See Table 1 for particle-diameter specifications of experimental particle.

(3) Static box test:

a) PASS the atomized monodisperse solid aerosol particles with an aerodynamic equivalent diameter of (3 ± 0.5) μm into the static box and MIX fully; USE the aerosol detection equipment to measure the size and concentration of the aerosol extracted at more than three points in the static box to ensure uniform concentration of aerosol in the static box. Aerosol concentration's relative standard deviation of three points shall be ≤ 10%, RECORD the average concentration of aerosol of three points as C_{111}.

b) START the sampling pump of the tested monitoring instrument, after running for some time, STOP sampling; USE the aerosol detection instrument to measure the aerosol's particle concentration C_{211} collected by the instrument; according to Formula (3), CALCULATE the aerosol's trapping efficiency of particle-diameter as η_{11}.

c) Sequentially and respectively GENERATE eight kinds of atomized monodisperse solid aerosols with different particle-diameters listed in Table 1. REPEAT above operations a) - b) until the test of eight kinds of atomized monodisperse solid aerosol with different particle-diameters are completed, and OBTAIN C_{1ij} and C_{2ij}.

d) REPEAT operation c) for three times; OBTAIN 24 data of trapping efficiency from 8 the groups.

(2) Aerosol generating. GENERATE the particulate matter with a concentration of (150 ± 10) μg/m^3 by polydispersity dust generator.

(3) Loading test:

a) INLET the generated particulate matter into the static box and MIX fully. To ensure the uniform particle concentration in static box, USE aerosol detecting instrumentation to measure the particle concentration in static at box more than three points, of which the relative standard deviation shall be ≤10%,

b) START the under-tested monitoring instrument, continuously RUN for a maintenance cycle (running time ≥7d, ≥20h per day); and then be loaded.

C) After loading operation is completed, according to 7.2.1 cutter under test shall conduct cutting performance test. Cutting performance indicators D_{a50} and δ_g of cutter under test shall meet the requirements of 6.2.2.

7.2.9.2 Loading test method of practical samples

(1) PUT the test $PM_{2.5}$ continuous monitoring system in the ambient with a $PM_{2.5}$ concentration of 100-150μg/m^3 and continuously RUN for a maintenance cycle (running time ≥7d, ≥ 20h per day); and then be loaded.

(2) After loading operation is completed, according to 7.2.1 cutter under test shall conduct cutting performance test. Separating performance indicators D_{a50} and δ_g of cutter shall meet the requirements of 6.2.2.

7.2.10 Parallelism of monitors [Parallelism of monitoring instruments]

Under the same test environment condition, ADJUST the sampling inlet of three under-tested monitoring instruments to the same height; the distance between under-tested monitoring instruments is 2-4m; after respectively calibrating the sample flow-rate and setting, CONDUCT instrument parallelism test. TEST $PM_{2.5}$ concentration in the ambient air, and successively TEST each sample for 24h with 23 groups' testing samples at least. RECORD the each measured $PM_{2.5}$ sample concentration value C_{ij} of each under-tested monitoring instrument, i is the number of under-tested monitoring instrument (i=1-3), j is the serial number of the test sample (j=1-23); the average value of each sample measured result of three under-tested monitoring instruments is $\overline{C_j}$. When $\overline{C_j}$<6μg/m^3, the test results is invalid. CALCULATE the relative standard deviation P_j of three monitoring instruments' test results according to Formula (27), and the calculated parallelism P of three under-tested monitoring instruments by Formula (28) shall comply with the requirements of

The daily average value of concentration of particulate matter under standard condition is calculated according to Formula (A4);

$$\overline{C} = \frac{\sum_{i=1}^{n} C_{sn,i}}{n} \quad (A4)$$

Where: $\overline{C}$ -- Daily average of mass concentration of monitoring instrument, μg/m^3;

$C_{sn,i}$ -- Mass concentration of particulate matter under standard condition for monitoring instrument in the i-th hour, μg/m^3;

n -- Monitoring hour-number on that day ($20 \leq n \leq 24$).

Translation References and Original Chinese Documents

[1] HJ 653-2013 Ambient air particulate matter (PM10 and PM2.5) continuous automatic monitoring system technical requirements and test methods. http://www.chinesestandard.net/Default.aspx?PDF-English-ID=HJ%20653-2013