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**Protective clothing - Chemical protective clothing
against solid particulates**

防护服装 固体颗粒物化学防护服

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Protective clothing - Chemical protective clothing against solid particulates

1 Scope

This Standard specifies the gradation, basic performance requirements, test methods and identification of chemical protective clothing against solid particulates.

This Standard applies to the protective clothing that is required for the skin protection of workers who are exposed to chemical contamination of particulates in the workplace environment.

This Standard does not include technical requirements for supporting personal protective equipment such as respiratory protective equipment, protective gloves, protective shoes and other personal protective equipment.

2 Normative references

The following documents are indispensable for the application of this document. For dated references, only the dated version applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 3917.3, Textiles - Tear properties of fabrics - Part 3: Determination of tear force of trapezoid-shaped test specimens

GB/T 3923.1, Textiles - Tensile properties of fabrics - Part 1: Determination of maximum force and elongation at maximum force using the strip method

GB/T 4744, Textiles - Testing and evaluation for water resistance - Hydrostatic pressure method

GB/T 12586, Rubber or plastics-coated fabrics - Determination of resistance to damage by flexing

GB/T 13640, Size designation of protective clothing

GB/T 13773.1, Textiles - Seam tensile properties of fabrics and made-up textile articles - Part 1: Determination of maximum force to seam rupture using the strip method

GB/T 20655, Protective clothing - Mechanical properties - Determination of the resistance to puncture

4.1.3 The protective clothing shall be compatible with other relevant personal protective equipment as much as possible.

4.1.4 After maintenance according to the method that is recommended by the manufacturer, protective clothing that can be used multiple times shall meet the requirements that are specified in 4.3.

4.2 Design requirement

The design of protective clothing shall:

- a) at least provide protection to the wearer's torso, head, arms and legs;
- b) The fabric and style of protective clothing shall meet the requirements to prevent the penetration of particles.

4.3 Performance requirements

4.3.1 Overall protective performance of protective clothing

Perform the overall protective performance test of protective clothing according to the provisions of 5.1. It is required that the inward leakage of protective clothing to particulate matter $L_{jmn, 82/90} \leq 30\%$; the total inward leakage of each protective clothing $L_{S, 8/10} \leq 15\%$.

Note 1: $L_{jmn, 82/90}$: inward leakage that is expressed in percentages. 82/90 refers that when all 90 leakages are arranged in order from small to large, take the 82nd inward leakage. The data includes all test actions, collection points and inward leakage of protective clothing.

Note 2: $L_{S, 8/10}$: the total inward leakage of each piece of protective clothing. 8/10 refers to the 8th value of the total inward leakage of all 10 pieces of protective clothing in order from small to large.

Note 3: If more than 10 pieces of protective clothing are tested, for the $L_{jmn, 82/90}$ data, select at 91% from all leakages in ascending order; for the $L_{S, 8/10}$ data, select at 80% from all total inward leakages in ascending order.

4.3.2 Fabric penetration resistance to particles

According to the provisions of 5.2, perform the test of protective clothing fabric penetration resistance to solid particles. According to the lowest value of the fabric penetration efficiency test result, it is graded and identified according to Table 1; the fabric penetration efficiency shall not be lower than grade 1.

5.4 The wear resistance of the fabric is tested according to the method that is specified in GB/T 21196.2; the sandpaper is required to be in accordance with the provisions of Appendix F of GB 24539-2009.

5.5 The fabric flexural failure resistance is tested according to the method that is specified in GB/T 12586.

5.6 The fabric tear strength is tested according to the method that is specified in GB/T 3917.3.

5.7 The fabric breaking force is tested according to the method that is specified in GB/T 3923.1.

5.8 The fabric puncture resistance is tested according to the method that is specified in GB/T 20655.

5.9 The fabric high temperature resistance and low temperature resistance is tested according to the method that is specified in 6.15 of GB 24539-2009.

5.10 The seam strength of protective clothing is tested according to the method that is specified in GB/T 13773.1.

6 Identification

6.1 Permanent identification

The protective clothing shall have the product name, implementation standard, product category code, production date, manufacturer name and address, and size specifications.

6.2 Certificate of quality

The content of the certificate of quality shall include at least the product name, size specifications, batch or production date, factory name and factory address.

6.3 Packaging

The protective clothing and its independent outer packaging shall have the product name, trademark, product category code, and size specifications.

6.4 Instruction book

Product instruction book shall be included in the individual packaging of the protective clothing; the product instruction book shall include at least:

- a) restrictions on use;
- b) product type and main performance grade;

Appendix A

(Normative)

Test method for inward leakage of chemical protective clothing against solid particulates

A.1 Scope

This Appendix specifies the test method for the inward leakage of protective clothing.

A.2 Principle

The aerosol generator generates standard NaCl particle aerosols and passes into the test room to maintain a relatively stable state. The measured object wears the measured protective clothing and performs the test action in the test room according to a predetermined plan. The particle detector measures the concentration of NaCl particle aerosol in the measured protective clothing at a fixed sampling point; evaluate the overall protective performance of the protective clothing against particles by the following indicators:

- the single inward leakage L_{ijmn} at each sampling point;
- the total inward leakage L_S of each piece of measured protective clothing;
- the total inward leakage L_H of each measured object;
- the total inward leakage L_E of each test action;
- the total inward leakage L_P at each sampling point;
- the average total inward leakage $\bar{L}$.

A.3 Test device

Figure A.1 and Figure A.2 are the layout of the inward leakage detection device.

7 -- flow meter;

8 -- horizontal pedal transmission test bench;

9 -- pipeline and baffle;

10 -- dry, clean air.

Note: For certain types of particle detectors, due to the limitation of the detection device range, it's necessary to use clean air carrier gas to dilute the sample air. During the test, in order to avoid condensation in the pipeline, send dry and clean air to the air pipeline (5) behind the sampling probe; or heat the pipeline or use other suitable methods to prevent condensation. When calculating the concentration at the sampling point, the dilution of the carrier gas shall be considered.

Figure A.2 -- Layout of the test device with improved test method (add additional dry and clean air at the test tube)

A.3.1 NaCl particle aerosol generator

1 unit; the generated gas volume is not less than 100 L/min; the NaCl particle aerosol concentration is $(10 \pm 1) \text{ mg/m}^3$; the concentration change in the effective space of the test room is $\leq \pm 10\%$. The aerodynamic particle size distribution of particles shall be $(0.02 \sim 2) \mu\text{m}$; the mass median diameter is about $0.6 \mu\text{m}$.

A.3.2 Particle detector

2 detectors, which are, respectively, used to detect the aerosol concentration of NaCl particles in the test room and the measured protective clothing. The dynamic range is $(0.001 \sim 200) \text{ mg/m}^3$; the accuracy is $\pm 1\%$; the response time of the detector is $\leq 500 \text{ ms}$.

A.3.3 Horizontal pedal transmission test bench

1 set; the running speed is $(5 \pm 0.5) \text{ km/h}$; it is installed in the test room.

A.3.4 Sampling pump and air line

2 sets, which are, respectively, used to collect and detect the NaCl particle aerosol in the test room and the measured protective clothing. The flow range is $(0.05 \sim 4) \text{ L/min}$; the flow fluctuation is $< \pm 0.2 \text{ L/min}$. It can be guaranteed that the sampling probe can sample at a flow rate of $(2 \pm 0.5) \text{ L/min}$ inside the measured protective clothing.

In order to ensure that the decompression that is generated by sampling in the measured protective clothing does not cause additional inward leakage, it shall be delivered into the measured protective clothing at the rate of $(2 \pm 0.5) \text{ L/min}$ while sampling. Clean air can be input through one of the other two sampling

additional equipment that is worn by the measured object (such as protective gloves or protective boots), there is no need to fix it.

A.6.3.2 Measure the basic test environmental concentration in the test room

Let the measured object enter the test room. Before the aerosol generator works, measure and report the air sample concentration that is taken by all three sampling probes as the measured basic test environmental concentration (Table A.1 No. 1). If the basic test environmental concentration is high, it shall investigate the cause and correct it, so as to ensure that the basic test environmental concentration is at an appropriate level.

A.6.3.3 Measure the test room environmental concentration

Start the aerosol generator until the aerosol concentration of NaCl particles in the test room environment is stabilized. Make sure that the measured object stays still during this process. Measure and report the aerosol concentration of NaCl particles in the test room environment (corresponding to Table A.1 No. 2).

If the aerosol concentration of NaCl particles in the test room environment needs more than 1 min to stabilize, the inside of the measured protective clothing shall be ventilated, so as to avoid the penetration of particles into the measured protective clothing.

A.6.3.4 Test

A.6.3.4.1 In accordance with the sampling order in Table A.1, respectively sample to measure the NaCl particle aerosol concentration at three positions, namely the knee (side), waist (back), and chest (right) of the measured object. Calculate and report the average concentration of the last 100 s of each test action and the average concentration of each sampling point. An integral recorder shall be used to measure the average concentration.

A.6.3.4.2 Complete the test of a protective clothing; turn off the aerosol generator; stop sampling and testing.

A.6.3.4.3 According to the above steps, complete the detection of 10 pieces of protective clothing samples, in total, through 5 measured objects, in turn.

A.6.3.5 Matters needing attention

- a) While the test is in progress, the measured object shall not be given any hints about the test results.
- b) At the end of each protective clothing test, the NaCl particle aerosol concentration in the test room environment shall not exceed the range of $\pm 10\%$ of the NaCl particle aerosol concentration in the test room

A.7.2.6 Average total inward leakage

According to Formula (A.7), respectively calculate the average value of the total inward leakage of the measured object, the measured protective clothing, the test action, and the measured position, and report it.

$$\bar{L} = \frac{1}{j} \sum_j L_{S,j} = \frac{1}{i} \sum_i L_{H,i} = \frac{1}{m} \sum_m L_{E,m} = \frac{1}{n} \sum_n L_{P,n} \dots\dots\dots (A.7)$$

Where:

$\bar{L}$ -- the average value of the total inward leakage.

A.8 Test report

The test report shall contain the following information:

- a) reference to this method.
- b) information of the protective clothing manufacturer.
- c) the size of the measured protective clothing and the body measurement of the measured object in accordance with the provisions of GB/T 13640.
- d) a description of the underwear that is worn by the measured object.
- e) a description of the pretreatment and/ or pre-conditioning of the measured protective clothing, such as the mechanical prestress that is applied to the protective clothing in order to determine the protective effectiveness of the protective clothing against particulate aerosols.
- f) a description of any additional protective equipment or any accessories that are worn during the test, and whether and how the accessories are connected to the measured protective clothing.
- g) the temperature and relative humidity inside the test room before and after the test of each piece of measured protective clothing,
- h) Prior to the test of each piece of protective clothing, measure the concentration of NaCl particle aerosols at all three sampling positions inside the protective clothing; measure the concentration of NaCl particle aerosol in the test room when it is stable, and the reagent concentration inside the test room at the end of the protective clothing test.
- i) Refer to the template that is given in Table A.2, report the inward leakage percentage L_{ijmn} and average value of each piece of measured protective clothing.

The main technical parameters are as follows:

- a) For NaCl particle generator (aerosol generator in Figure B.1), the generated NaCl particle concentration is $(12 \sim 20) \text{ mg/m}^3$; the count median diameter (CMD) is $(0.075 \pm 0.020) \mu\text{m}$; the geometric standard deviation of particle size distribution is ≤ 1.83 ;
- b) The detection flow rate is $(15 \pm 2) \text{ L/min}$;
- c) The air flow through the filter material (see Figure B.1) has a cross-sectional area of 100 cm^2 ;
- d) The dynamic range of the high-concentration particulate detector (i.e., the upstream photometer in Figure B.1) is $(0.001 \sim 200) \text{ mg/m}^3$; the accuracy is 1%; the dynamic range of low-concentration particulate detector (i.e., the downstream photometer in Figure B.1) is $(0.001 \sim 200) \text{ mg/m}^3$; the accuracy is 1%;
- e) The penetration detection range is $0 \sim 99.999\%$;
- f) There shall be a heater to dry the moisture of NaCl particles;
- g) There shall be a device that can neutralize the charge of the generated particulates (aerosol neutralizer in Figure B.1);
- h) Compressed air source requirement: 198 L/min at 550 kPa .

B.3.2 Chemical reagents

- a) Solid NaCl: at least chemically pure;
- b) test water: distilled water or purified water.

B.3.3 Sample

Take two sets of protective clothing at random; for each set of protective clothing, take 3 seamed samples, 3 seamless samples; the sample size is $\phi 150 \text{ mm}$. The seam of the seamed sample shall be in the middle of the sample.

B.4 Test environment conditions

The test environment temperature is $(25 \pm 5) ^\circ\text{C}$; the relative humidity is $(30 \pm 10)\%$.

B.5 Test procedure

Prepare the NaCl solution at a rate of 20 g of solid NaCl per $1\,000 \text{ mL}$ of water. Pour into the NaCl particle generator.

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