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**Protective clothing - High visibility warning clothing for
professional use**

防护服装 职业用高可视性警示服

(ISO 20471:2013, High visibility clothing - Test methods and requirements,
MOD)

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Table of Contents

Foreword	3
1 Scope	7
2 Normative references	7
3 Terms and definitions	9
4 Level and design requirements	10
5 Performance requirements for background materials, non-fluorescent materials and combined-performance materials	14
6 Reflective performance requirements for retroreflective materials and combined-performance materials.....	17
7 Test methods	19
8 Marks, maintenance labels and instructions for use.....	22
Annex A (informative) Typical design styles of warning clothing	24
Annex B (informative) Chromaticity diagrams for background materials and combined-performance materials.....	28
Annex C (normative) Method for determination of retro reflection coefficient	29
Annex D (normative) Arrangement of reflective tapes during industrial washing.....	34
Annex E (normative) Method for determination of reflective performance in rainy conditions	35
Annex F (informative) Environmental risk level and visibility clothing design guidance	38
Bibliography	41

Protective clothing - High visibility warning clothing for professional use

1 Scope

This Standard specifies the design requirements, material performance requirements, reflective performance requirements, test methods, marks, maintenance labels and instructions for use of high visibility warning clothing for occupational use.

This Standard applies to high visibility warning clothing worn by workers in low-visibility environments to improve their visual visibility.

2 Normative references

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

GB/T 250, *Textiles -- Tests for colour fastness -- Grey scale for assessing change in colour* (GB/T 250-2008, ISO 105-A02:1993, IDT)

GB/T 251, *Textiles -- Tests for colour fastness -- Grey scale for assessing staining* (GB/T 251-2008, ISO 105-A03:1993, IDT)

GB/T 1335.1, *Standard sizing systems for garments -- Men*

GB/T 1335.2, *Standard sizing systems for garments -- Women*

GB/T 3920, *Textiles -- Tests for colour fastness -- Colour fastness to rubbing* (GB/T 3920-2008, ISO 105-X12:2001, MOD)

GB/T 3922, *Textiles -- Tests for colour fastness -- Colour fastness to perspiration* (GB/T 3922-2013, ISO 105-E04:2013, MOD)

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 3923.1-2013, ISO 13934-1:1999, MOD)

GB/T 3978, *Standard illuminants and geometric conditions* (GB/T 3978-2008, CIE 15:2004, CIE S005:1999, NEQ)

GB/T 3979, *Methods for the measurement of object color* (GB/T 3979-2008, CIE

Materials that have both background material properties and retroreflective material properties.

3.8 orientation sensitive material

Retroreflective material that when the rotation angles are 0° and 90° respectively, the difference in retro reflection coefficient is greater than 15%.

3.9 non-fluorescent material

The fabric that usually forms the main body of the outer layer of warning clothing together with the background material does not meet the requirements for retroreflective materials and background materials in this Standard.

4 Level and design requirements

4.1 Level

According to the relative strength of visibility, high visibility warning clothing (warning clothing for short) is divided into 3 levels. Each level of warning clothing shall contain a corresponding area of visible material (background material, retroreflective material, or combined-performance material). The minimum usage area of visible materials on warning clothing is shown in Table 1.

When measuring area, the smallest design size of the clothing shall be selected. Fasten all zippers, buckles and other fasteners to the minimum position. Place the clothing flat on a table to measure. The measurement area includes the trunk and limbs.

When calculating the usage area of visibility materials, only materials that meet the design requirements of 4.2 are included. When using two or more background materials, color is not considered. Calculate area uniformly. Patterns, printing or labels of any kind are not included in the calculation of the minimum visible area in Table 1.

A single piece of clothing or a complete set of clothing (such as a top and pants) can be assessed as a warning clothing level. If after the user puts on the entire set of clothing, the visible material area of the entire set of clothing satisfies a warning clothing level higher than that of any single piece of clothing, the level of the warning clothing can be assessed based on the visible material area of the entire set of clothing. The warning clothing level of the entire clothing shall be marked on the label and instructions for use of each individual clothing.

To ensure 360° visibility, all sides of the clothing shall be designed with visible materials. Horizontal reflective tape and fluorescent material shall surround the torso, pant legs and sleeves. The area of visible materials configured on the front and back of clothing shall not be less than 40% of the minimum usage area of visible materials for corresponding level warning clothing.

shirts/coats, T-shirts, etc.)

The design of warning clothing (such as jackets, shirts/coats, T-shirts, etc.) that covers the upper torso and arms shall meet the following requirements. See Figure A.2 for a schematic diagram of typical design styles.

- a) The background material shall surround the upper torso area and sleeves. The width shall not be less than 50 mm (the area where the background material is interrupted by the reflective tape is not included). The minimum width of reflective tape for level 2 and level 3 warning clothing is 50 mm. The minimum width of reflective tape for level 1 warning clothing is 25 mm.
- b) Warning clothing covering the upper torso and arms shall have at least one reflective strip surrounding the torso. The maximum tilt angle between the reflective tape and the horizontal line is $\pm 20^\circ$. There shall be a reflective strip on each shoulder extending from chest to back. Extend at least 15 cm from the shoulder seam to the chest and back or connect to the reflective tape on the torso. The distance between the bottom of the lowest reflective tape on the torso and the bottom of the clothing shall be no less than 50 mm. If the clothing has multiple horizontal reflective tapes, the distance between two adjacent ones shall be no less than 50 mm.
- c) Alternatively, warning clothing covering the upper torso and arms shall have at least two reflective tapes surrounding the torso when reflective tape surrounds the sleeves. The distance between adjacent reflective strips shall not be less than 50 mm. The maximum tilt angle between the reflective tape and the horizontal line is $\pm 20^\circ$. The distance between the bottom of the lowest reflective tape on the torso and the bottom edge of the clothing shall not be less than 50 mm.
- d) If the sleeve significantly blocks a horizontal reflective strip on the torso, a circle of reflective strip shall be placed around the sleeve. If it is long sleeves, the sleeves shall be surrounded by two reflective tapes spaced no less than 50 mm apart.
- e) If the sleeves significantly block two horizontal reflective strips on the torso, the sleeves shall be surrounded by two reflective strips spaced no less than 50 mm apart. The distance between the bottom of the lowest reflective tape and the edge of the cuff shall be no less than 50 mm. You can move your arms in different postures and observe how well the sleeves block the horizontal reflective tape.
- f) The gaps along the length of strips made of retroreflective material or combined-performance material (such as plackets or seams) shall be no greater than 50 mm. If the strip wraps around the torso or sleeves, the total gap on the strip shall not larger than 100 mm.

4.2.3 Warning clothing that mainly covers the legs (such as trousers, overalls, etc.)

The design of warning clothing that mainly covers the legs (such as trousers, overalls, etc.) shall meet the following requirements. See Figure A.3 for a schematic diagram of typical design styles.

- a) The background material shall wrap around the pant leg. The width is not less than 50 mm (the area where the background material is interrupted by the reflective tape is not included). The minimum width of reflective tape for level 2 and level 3 warning clothing is 50 mm. The minimum width of reflective tape for level 1 warning clothing is 25 mm.
- b) Warning clothing covering the legs shall have at least two reflective strips spaced no less than 50 mm apart. The maximum tilt angle of the reflective tape is $\pm 20^\circ$. The distance between the bottom of the lowest reflective tape and the edge of the pants opening shall be no less than 50 mm.
- c) The gaps in the length direction of strips composed of retroreflective materials or combined-performance materials (such as plackets or seams) shall not be greater than 50 mm.

4.2.4 Warning clothing that covers the upper torso and legs (such as sleeveless coveralls)

The design of warning clothing (such as sleeveless overalls) that covers the upper torso and legs shall meet the following requirements. See Figure A.4 for a schematic diagram of typical design styles.

- a) The background material shall surround the upper torso area and pant legs. The width is not less than 50 mm (the area where the background material is interrupted by the reflective tape is not included). The minimum width of reflective tape for level 2 and level 3 warning clothing is 50 mm. The minimum width of reflective tape for level 1 warning clothing is 25 mm.
- b) The requirements of 4.2.1 and 4.2.3 shall be met simultaneously.

4.2.5 Warning clothing that covers the upper torso, arms and legs (such as coveralls)

Warning clothing that covers the upper torso, arms and legs (such as coveralls) shall be designed to meet the following requirements. See Figure A.5 for a schematic diagram of typical design styles.

- a) The background material shall surround the upper torso area, sleeves, and pant legs. The width is not less than 50 mm (the area where the background material is interrupted by the reflective tape is not included). The minimum width of reflective tape for level 2 and level 3 warning clothing is 50 mm. The minimum width of reflective tape for level 1 warning clothing is 25 mm.

The breaking strength of woven materials in the warp and weft directions shall not be less than 100 N.

5.5.2 Bursting strength of knitted materials

Test according to the method specified in GB/T 7742.1.

When the test area is 50 cm², the bursting strength shall not be less than 100 kPa. Or, when the test area is 7.3 cm², the bursting strength shall not be less than 200 kPa.

5.5.3 Breaking strength and tearing strength of coated fabrics and composite fabrics

When the outermost material of the warning clothing is coated fabric or composite fabric, the breaking strength shall not be less than 100 N (not applicable to materials with an elongation greater than 50%). Test according to method 1 specified in HG/T 2580-2008.

The tearing strength shall be no less than 20 N (not applicable to materials with elongation greater than 50%). Test according to Method A specified in HG/T 2581.1-2009.

5.6 Moisture permeability

Test according to the method specified in GB/T 12704.1.

Except for vests and pullover vests with openings on both sides, the moisture permeability of the background material and non-fluorescent materials shall not be less than 5000 g/(m² · 24h).

5.7 Chemical safety performance requirements

Background materials and non-fluorescent materials shall meet the following requirements.

- a) pH value is between 4.0~8.5;
- b) The formaldehyde content shall not be greater than 75 mg/kg (direct contact with skin), or not greater than 300 mg/kg (indirect contact with skin). Conduct pH value and formaldehyde content tests according to 6.1 and 6.2 of GB 18401-2010.

6 Reflective performance requirements for retroreflective materials and combined-performance materials

6.1 Reflective properties before physical testing

relative humidity of $(65\pm 4)\%$. If the test needs to be conducted under other conditions, the test shall be conducted within 5 min after the specimen is removed from the humidity-controlled environment.

7.2 Color performance

The standard illuminant D65 light source specified in GB/T 3978, the geometric condition 45/0, and the 2° standard chromaticity observer are used. Test according to the method specified in GB/T 3979.

During the test, there shall be a black padding underneath the single-layer specimen (including the original padding or lining of the clothing). The retro reflection coefficient of the backing shall be less than 0.04.

Test at least once in each of the four orthogonal directions. Take its mean value. If the light source is incident from the annulus, only one measurement can be performed.

7.3 Dimensional changes in materials

The preparation, labeling and measurement of samples shall be carried out in accordance with the relevant provisions of GB/T 8628-2013.

Priority shall be given to cleaning according to the cleaning methods and procedures recommended in the clothing's instructions for use.

When warning clothing is suitable for industrial laundering, industrial laundering is preferred.

When suitable for home washing, the procedures specified in GB/T 8629-2017 shall be followed. If the clothing care label does not indicate a washing procedure, the 6N program shall be used for washing. A complete wash cycle includes washing and drying.

When it is only suitable for dry cleaning, the procedures specified in GB/T 19981.2 shall be followed.

After completing 5 cleanings according to the selected method, take dimensional measurements.

7.4 Reflective properties

The retro reflection coefficient shall be tested according to the method specified in Annex C. If the size of a single reflective tape cannot meet the test requirements, it can be spliced. The retro reflection coefficient shall be measured at two rotation angles of 0° and 90° respectively. The position of 0° rotation angle is determined according to the following conditions:

- A) Clear orientation markings on each specimen;

- b) Material manufacturers provide clear instructions.

If there are no markings or instructions, the 0° rotation angle position can be chosen arbitrarily.

7.5 Physical test

7.5.1 Wear resistance

Test according to the specimen inversion mode in GB/T 21196.2. A downward pressure of 9 kPa is applied during the test. Use wool fabric abrasive. After 5000 cycles of wear, the retro reflection coefficient of the specimen is tested.

7.5.2 Yielding

According to the provisions of Method A in GB/T 12586-2003. Perform a yielding test on the specimen. After 7500 cycles of yielding, the retro reflection coefficient of the specimen is tested.

7.5.3 Low temperature bending

According to the provisions of GB/T 18426, place and fold the specimen at $(-20\pm 2)^{\circ}\text{C}$. Adjust humidity for at least 2 h under the conditions specified in 7.1.2. Then test the retro reflection coefficient.

7.5.4 Temperature change

Take two 100 mm long reflective tapes and perform the following preprocessing steps:

- a) Place it under the conditions of $(50\pm 2)^{\circ}\text{C}$ for 12 h, and then proceed to item b) immediately;
- b) Place at $(-30\pm 2)^{\circ}\text{C}$ for 20 h;
- c) Adjust humidity for at least 2 h under the conditions specified in 7.1.2.

Then the reflective tapes are spliced into a 100mm×100mm specimen. Test the retro reflection coefficient of the specimen.

7.5.5 Water washing and dry cleaning

7.5.5.1 Sample selection

Finished clothing shall be selected, or the background material and retroreflective material can be fixed and then cleaned.

7.5.5.2 Fixing method

For household laundering and dry cleaning, take three 300mm x 250mm specimens of

background material. Two 250 mm reflective tapes are fixed to each background material specimen. The spacing between the two strips is 50 mm.

For industrial laundering, follow Annex D for sampling and positioning.

7.5.5.3 Cleaning methods

Priority shall be given to cleaning according to the cleaning methods and procedures recommended in the clothing's instructions for use.

If the cleaning method is unclear, when the warning clothing is suitable for washing, the 6 N procedure specified in GB/T 8629-2017 shall be used. A complete wash cycle shall include washing and drying. When it is only suitable for dry cleaning, the procedures specified in GB/T 19981.2 shall be followed.

If a maximum number of cleanings is given in the product instructions, this maximum number of cleanings shall be followed. If the product instructions do not give a number of cleanings, 15 cleanings shall be performed.

7.6 Getting wet in rain

The specimens shall be tested according to the method specified in Annex E.

Orientation sensitive materials shall be tested at a rotation angle with a smaller retro reflection coefficient in the dry state.

8 Marks, maintenance labels and instructions for use

8.1 Marks

Product marks shall include the following information:

- a) Clothing shall have durable maintenance labels on the inside of their collars and waistbands. The label shall contain product information such as product name, size or specification, washing method, and warning clothing graphic symbols (see Figure 1). Instructions for use shall indicate the product name, as well as production information such as factory name, factory address, product execution standards, washing methods;
- b) The graphic symbols of the warning clothing and the level of the warning clothing shall be marked on the label and instruction manual of each single piece of clothing. It shall be stated that the level is used as a complete set of warning clothing, or as a level of a single piece of warning clothing.

8.2 Maintenance labels

The maintenance label of the warning clothing shall indicate the maintenance method

Annex C

(normative)

Method for determination of retro reflection coefficient

C.1 Terms and definitions

C.1.1 retroreflector

Reflective surface or device with retroreflective properties.

C.1.2 retroreflector center

A point on or near a retroreflector used to indicate the location of a retroreflector.

C.1.3 reference axis

A straight line starting from the reference center and perpendicular to the reflective surface of the test specimen.

C.1.4 illumination axis

A ray emanating from the center of the retroreflector and passing through the light source point.

C.1.5 observation axis

A ray emanating from the center of the retroreflector and passing through the observation point.

C.1.6 entrance angle; β

The angle between the axis of illumination and the axis of the retroreflector.

C.1.7 observation angle; α

The angle between the illumination axis and the observation axis.

C.1.8 coefficient of luminous intensity; R_l

The luminous intensity I of the retro reflection in the viewing direction is divided by the illuminance $E_{\perp}$ of the plane directed toward the retroreflector and falling perpendicular to the direction of the incident light.

Annex E

(normative)

Method for determination of reflective performance in rainy conditions

E.1 Principle

Install the specimen on a vertical plane and continuously spray water on the specimen. During the water spraying process, measure the retro reflection coefficient value of the wet surface of the specimen. This method is used to determine the optical properties of retroreflective materials under simulated rain conditions.

E.2 Equipment

The simulated rainfall equipment is shown in Figure E.1.

Specimen A is fixed on the vertical specimen holder B, located above the water collection tank C and the drainage outlet D. The specimen holder is firmly installed on the goniometer table (not shown in the figure), keeping a certain distance from the goniometer. The nozzle E is set at a fixed position relative to the specimen. The pressure is adjusted through the flexible interface F or the hose to continuously spray tap water.

The distance between nozzle E and specimen A is 1000 mm. The angle is set so that the ejected water column hits the sample at an angle of $10^{\circ} \pm 5^{\circ}$ in the vertical direction. The specimen, specimen holder and nozzle are sealed in a hood G to prevent the optical measuring equipment from coming into contact with water.

It is best to make the cover G from a large area of rigid transparent plastic material. Keep at least one movable panel or door for easy observation on the one hand and easy operation on the other hand. A square hole H with a side length of 150 mm is used as a passage for light. Gutter I is used to help square hole H block falling water. The part of the cover G close to the square hole H is sprayed with matte black paint to reduce scattering. Nozzle E contains a 1.19 mm diameter orifice and a properly designed water supply pipe to ensure a stable and uniform cone-shaped water column.

E.3 Test procedures

Calibrate optical test equipment. The retro reflection coefficient R_A of the measuring device is corrected separately in the dry state and in the wet state. Determine the correction factor for the change in scattered light between the wet and dry states (determine the change in R_A between the two states).

Mount a flat, square specimen with a side length of not less than 50 mm on a vertical plane on a vertical specimen holder. The specimen holder shall not protrude beyond the

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