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High visibility clothing — Test methods and requirements

Vêtements à haute visibilité — Méthodes d'essai et exigences

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 20471 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*.

This corrected version of ISO 20471:2013 incorporates the following correction:

— in the fourth paragraph of subclause 4.1 the requirement concerning the sleeves of a class 3 garment has been corrected.

Introduction

The performance of the conspicuity-enhancing materials to be used for high risk-related visibility clothing is specified photometrically together with minimum areas and placement (design) requirements.

Conspicuity is the property that makes an object readily attract visual attention. This is a particularly important feature in complex environments which have visually competing objects. Conspicuity is determined by an object's luminance contrast, colour contrast, pattern and design, and motion characteristics relative to the ambient background against which it is seen.

Three classes of garment are defined based on three different minimum areas of retroreflective, fluorescent and/or combined performance materials. Each of these classes will provide a different level of conspicuity, class 3 being the class that provides the highest degree of conspicuity against most backgrounds found in urban and rural situations in daylight and in night time. Users should select the required class of performance based on a risk assessment of the location/situation in which the protection afforded by clothing to this International Standard is required.

This International Standard contains requirements relating to risk assessment and risk analysis of high visibility garments. Possible designs illustrating the placement of retroreflective materials are included within the standard. Ergonomic factors such as fit/sizing, comfort, and range of motion of the wearer should be considered when selecting the most appropriate configuration of retroreflective and fluorescent materials within the garment.

Selection and use of high visibility clothing can vary among user countries and may be subject to local regulations. This International Standard contains requirements relating to risk assessment of the condition in which the high visibility clothing is to be used. This will involve consideration of the factors which may affect an observer's ability to detect that a person is present. The observer needs both to perceive and to recognize the wearer and then needs to be able to take appropriate avoidance action. The wearing of a conspicuity-enhancing high visibility garment does not guarantee that the wearer will be visible under all conditions.

The minimum requirements given within this International Standard are determined by the specific test methods and their assigned measuring values. The tests are partly performed on new materials and partly on preconditioned materials. By preconditioning (e.g. folding of retroreflective material) a load of the materials is simulated. However, it should be noted that laboratory testing may not represent real life conditions. The conspicuity performance of a garment will depend on usage (e.g. dirt, solar irradiation), care (e.g. cleaning agent, repair), storage (e.g. dust-free, lightproof), etc.

High visibility clothing — Test methods and requirements

1 Scope

This International Standard specifies requirements for high visibility clothing which is capable of visually signalling the user's presence. The high visibility clothing is intended to provide conspicuity of the wearer in any light condition when viewed by operators of vehicles or other mechanized equipment during daylight conditions and under illumination of headlights in the dark. For further information concerning risk situations, see Annex A.

This International Standard is not applicable to medium-risk and low-risk situations.

Performance requirements are included for colour and retroreflection as well as for the minimum areas and for the placement of the materials in protective clothing.

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.

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 105-A03, *Textiles — Tests for colour fastness — Part A03: Grey scale for assessing staining*

ISO 105-B02:1994, *Textiles — Tests for colour fastness — Part B02: Colour fastness to artificial light: Xenon arc fading lamp test*

ISO 105-C06, *Textiles — Tests for colour fastness — Part C06: Colour fastness to domestic and commercial laundering*

ISO 105-D01, *Textiles — Tests for colour fastness — Part D01: Colour fastness to drycleaning using perchloroethylene solvent*

ISO 105-E04, *Textiles — Tests for colour fastness — Part E04: Colour fastness to perspiration — Part E04: Colour fastness to perspiration*

ISO 105-N01, *Textiles — Tests for colour fastness — Part N01: Colour fastness to bleaching: Hypochlorite — Tests for colour fastness — Part N01: Colour fastness to bleaching: Hypochlorite*

ISO 105-X11, *Textiles — Tests for colour fastness — Part X11: Colour fastness to hot pressing — Tests for colour fastness — Part X11: Colour fastness to hot pressing*

ISO 105-X12, *Textiles — Tests for colour fastness — Part X12: Colour fastness to rubbing*

ISO 1421:1998, *Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break*

ISO 4674-1:2003, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

ISO 4675, *Rubber- or plastics-coated fabrics — Low-temperature bend test*

ISO 7854:1995, *Rubber- or plastics-coated fabrics — Determination of resistance to damage by flexing*

ISO 11092, *Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)*

ISO 12947-2, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown*

ISO 13688:1998, *Protective clothing — General requirements*

ISO 13934-1, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 13938 (all parts), *Textiles — Bursting properties of fabrics*

EN 343, *Protective clothing — Protection against rain*

CIE 15, *Colorimetry*

CIE 54.2, *Retroreflection — Definition and measurement*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
high visibility clothing
warning clothing intended to provide improved conspicuity in situations where the risk of not being seen is high

3.2
fluorescent material
material that emits electromagnetic radiation at visible wavelengths longer than those absorbed

3.3
background material
coloured fluorescent material intended to be highly conspicuous, but not intended to comply with the requirements of this International Standard for retroreflective material

3.4
retroreflective material
material which is a retroreflector but which is not intended to comply with the requirements of this International Standard for background material

3.5
separate-performance material
material intended to exhibit either background or retroreflective properties but not both

3.6
combined-performance material
material intended to exhibit both background and retroreflective properties

3.7
orientation-sensitive material
material having coefficients of retroreflection that differ by more than 15 % when measured at the two rotation angles $\varepsilon_1 = 0°$ and $\varepsilon_2 = 90°$

3.8
torso
thorax and abdomen or section of the body to which the limbs, head and neck are attached

3.9
long sleeve
(1/1 arm)
part of a garment that is completely covering the arm

3.10
road
traffic-related area with moving vehicles

EXAMPLE Cycling path, harbour, airport, railway track and car park.

3.11
active road user
person on the road, participating in the traffic and with the attention on the traffic

Note 1 to entry: e.g. cyclist using the road and pedestrian using the road.

3.12
passive road user
person on the road, not participating in vehicular traffic and with attention focused on something other than traffic

EXAMPLE Road worker, person in emergency situation.

3.13
outer shell
outermost material of which the warning clothing is made

4 Design

4.1 Types and classes

High visibility clothing is grouped into three classes related to risk assessment. Each class shall have minimum areas of high visibility materials incorporated in the garment in accordance with Table 1. Garments shall comprise the required areas of background material and retroreflective material or alternatively shall comprise the required area of combined performance material. The area shall be measured on the smallest garment size available with all fasteners adjusted to the smallest configuration possible.

The garment shall be made up of high visibility material on all sides. To ensure visibility from all sides (360° visibility), it is important that horizontal retroreflective bands and fluorescent materials encircle torso, trouser legs and sleeves.

The performance class can be obtained using a single garment or a clothing ensemble, e.g. jacket and trousers. An assembly, e.g. a classified trouser and a classified jacket, can be classified as a higher class if the assembly meets the minimum requirement achieved by the actually visible area when wearing the garment. This higher class shall be additionally specified in both the information for use and on the labels of both garments (see Clause 8).

Regardless of the area of materials used, a class 3 garment shall cover the torso and shall have as a minimum either sleeves with retroreflective bands or full length trouser legs with retroreflective bands, if not both.

Table 1 — Minimum required areas of visible material in m^2

Material	Class 3 garments	Class 2 garments	Class 1 garments
Background material	0,80	0,50	0,14
Retroreflective material	0,20	0,13	0,10
Combined performance material	n. a.	n. a.	0,20
NOTE The clothing class is determined by the lowest area of visible material.			

The minimum visible area requirements to achieve a garment classification in Table 1 are not to be reduced or compromised due to the presence of any logos, lettering, labels etc.

At least (50 ± 10) % of the minimum area of visible background material shall be on the front part of the garment. Only those areas of retroreflective materials that comply with the design requirements of 4.2 shall be used in the assessment of the minimum required area of retroreflective areas. When using two or more background materials, the total area usable regardless of colour shall be measured. The garment is to be measured flat on the table including torso, arms and legs.

NOTE For additional information on high visibility garment design, see Annex D.

4.2 Specific design requirements

4.2.1 Garments covering only the torso

The background material shall encircle the torso and shall maintain a minimum width (height) of 50 mm. Interruptions of background material by retroreflective stripes are not counted. Bands of retroreflective material shall be at least 50 mm wide.

Garments only covering the torso shall have one or more bands of retroreflective material encircling the torso with a maximum inclination of ± 20° to the horizontal and bands of retroreflective material joining the torso band from the front to the back over each shoulder. The bottom of the lowest torso band shall be at least 50 mm above the bottom edge. If more than one horizontal band is applied the horizontal bands shall be at least 50 mm apart.

Alternatively, garments covering only the torso shall have two bands of retroreflective material at least 50 mm apart and encircling the torso with a maximum inclination of ± 20° to the horizontal. The bottom of the lowest torso band shall be at least 50 mm above the bottom edge.

Tabards shall be constructed so that a person of the size for which they are designed can wear the tabard so that any gaps at the sides shall not be greater than 50 mm horizontally.

Any gap (for fastening systems and seams) in the lengthwise continuity of each band of retroreflective or combined performance material shall not be greater than 50 mm, measured parallel to the direction of the band, and the total of such gaps shall not be greater than 100 mm in any one band around the torso.

Examples of garments covering only the torso are given in Figure 1.

Dimensions in millimetres

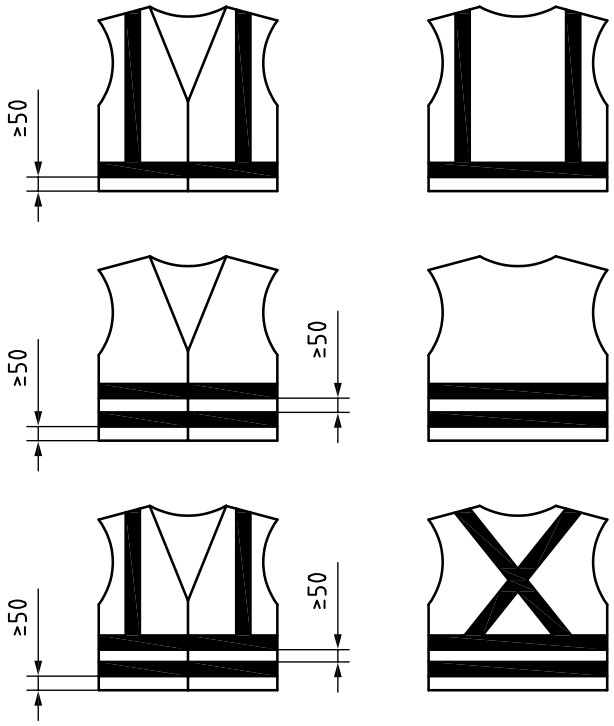

Figure 1 — Examples of garments covering only the torso

NOTE Examples of garments covering only the torso are vests and tabards.

4.2.2 Garments covering torso and arms

The background material shall encircle the torso and the sleeves and shall maintain a minimum width (height) of 50 mm. Interruptions by retroreflective stripes are not counted. Bands of retroreflective material shall be at least 50 mm wide.

Garments covering the torso and arms shall have one or more bands of retroreflective material encircling the torso with a maximum inclination of ± 20° to the horizontal and bands of retroreflective material joining the torso band from the front to the back over each shoulder. The bottom of the lowest torso band shall be at least 50 mm above the bottom edge. If more than one horizontal band is applied, the horizontal bands shall be at least 50 mm apart.

Alternatively, garments covering torso and arms shall have two or more bands of retroreflective material at least 50 mm apart and encircling the torso with a maximum inclination of ± 20° to the horizontal. The bottom of the lowest torso band shall be at least 50 mm above the bottom edge.

If a sleeve blocks a clear view of a horizontal torso band, then the sleeve shall be encircled by a retroreflective band. If it is a long sleeve (1/1 arm) garment, the sleeve shall be encircled by two bands of retroreflective material at least 50 mm apart.

If a sleeve blocks a clear view of two horizontal torso bands, then the sleeve shall be encircled with two retroreflective bands at least 50 mm apart with the lower band at least 50 mm above the sleeve edge. Testing regarding the clear view shall be done by visual inspection while moving the arm in all positions.

Any gap (for fastening systems and seams) in the lengthwise continuity of each band of retroreflective or combined performance material shall not be greater than 50 mm, measured parallel to the direction of the band, and the total of such gaps shall not be greater than 100 mm in any one band around the torso and 50 mm around the sleeves.

Examples for garments covering the torso and arms are given in Figure 2.