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**Protective clothing — Enhanced visibility
equipment for medium risk situations —
Test methods and requirements**

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Schutzkleidung - Erhöhte Sichtbarkeit für mittlere Risikosituationen - Prüfverfahren und Anforderungen

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European foreword

This document (EN 17353:2020) has been prepared by Technical Committee CEN/TC 162 “Protective clothing including hand and arm protection and lifejackets”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2021, and conflicting national standards shall be withdrawn at the latest by August 2023.

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

This document supersedes EN 1150:1999, and EN 13356:2001.

This document has been prepared under a standardization request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Regulation 2016/425.

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This document specifies requirements for enhanced visibility equipment in the form of garments, or devices, which are capable of visually signalling the user's presence.

The enhanced visibility equipment is intended to provide conspicuity of the wearer in medium risk situations under any daylight conditions and/or under illumination by vehicles headlights or searchlights in the dark.

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

This document is not applicable to:

- high visibility equipment in high-risk situations, which is covered in EN ISO 20471 (for further information concerning risk situations, see Annex A);
- visibility equipment specifically intended for the head, hands and feet, e.g. helmets, gloves and shoes;
- equipment integrating active lighting, e.g. LEDs;
- visibility for low-risk situations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 20105-A02:1994, *Textiles - Tests for colour fastness - Part A02: Grey scale for assessing change in colour (ISO 105-A02:1993)*

EN 20105-A03:1994, *Textiles - Tests for colour fastness - Part A03: Grey scale for assessing staining (ISO 105-A03:1993)*

EN 20105-N01:1995, *Textiles - Tests for colour fastness - Part N01: Colour fastness to bleaching: Hypochlorite (ISO 105-N01:1993)*

EN 60068-2-31:2008, *Environmental testing - Part 2-31: Tests - Test Ec: Rough handling shocks, primarily for equipment-type specimens (IEC 60068 2 31:2008)*

EN ISO 105-B02:2014, *Textiles - Tests for colour fastness - Part B02: Colour fastness to artificial light: Xenon arc fading lamp test (ISO 105-B02:2014)*

EN ISO 105-C06:2010, *Textiles - Tests for colour fastness - Part C06: Colour fastness to domestic and commercial laundering (ISO 105-C06:2010)*

EN ISO 105-D01:2010, *Textiles - Tests for colour fastness - Part D01: Colour fastness to dry cleaning using perchloroethylene solvent (ISO 105-D01:2010)*

EN ISO 105-E04:2013, *Textiles - Tests for colour fastness - Part E04: Colour fastness to perspiration (ISO 105-E04:2013)*

EN ISO 105-X11:1996, *Textiles - Tests for colour fastness - Part X11: Colour fastness to hot pressing (ISO 105-X11:1994)*

EN ISO 105-X12:2016, *Textiles - Tests for colour fastness - Part X12: Colour fastness to rubbing (ISO 105-X12:2016)*

EN ISO 12947-2:2016, *Textiles - Determination of the abrasion resistance of fabrics by the Martindale method - Part 2: Determination of specimen breakdown (ISO 12947-2:2016)*

EN ISO 13688:2013, *Protective clothing - General requirements (ISO 13688:2013)*

EN ISO 20471:2013, *High visibility clothing - Test methods and requirements (ISO 20471:2013, Corrected version 2013-06-01)*

ISO 4675:2017, *Rubber- or plastics-coated fabrics - Low-temperature bend test*

CIE 015:2018, *Colorimetry*

CIE 54.2:2001, *Retroreflection - Definition and measurement*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp/ui>

3.1

combined-performance material

material intended to exhibit both fluorescent and retroreflective properties

Note 1 to entry: “Fluorescent material” is defined as “background material” in EN ISO 20471:2013.

[SOURCE: EN ISO 20471:2013, 3.6]

3.2

dark condition

light conditions similar to light outside after sunset and before sunrise

3.3

daylight

light conditions similar to light outside after sunrise and before sunset

3.4

enhanced-visibility equipment

clothing/garment or device, intended to provide conspicuity during daylight and/or dark conditions and/or twilight

3.5

family of devices

group of devices made with identical raw materials (manufacturer, article number, reflected colour, product variation etc.) and identical manufacturing process as the base of model

3.6

flexible device

device that is capable of being bent

3.7

fluorescent material

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

Note 1 to entry: This term applies to daylight conditions.

Note 2 to entry: “Fluorescent material” is defined as “background material” in EN ISO 20471:2013.

[SOURCE: EN ISO 20471:2013, 3.2]

3.8

non-fluorescent material

material not intended to be highly conspicuous

3.9

optical active area

part of the retroreflective material which has not lost any of the original photometric properties during conversion into a device

Note 1 to entry: This includes, but it is not limited to, loss due to welding lines, holes or printing.

3.10

orientation sensitive material

material having coefficients of retroreflection that differ by more than 15 % when measured at the two rotation angles $\beta_1 = 0^\circ$ and $\beta_2 = 90^\circ$

[SOURCE: EN ISO 20471:2013, 3.7]

3.11

retroreflective element

portion of retroreflective material (stripe, band or any shape meeting the design criteria of this document)

3.12

retroreflective material

material which is a retroreflector, but which is not intended to comply with the requirements of this document for fluorescent material

[SOURCE: EN ISO 20471:2013, 3.4]

3.13

rigid device

device that is not capable of being bent

EXAMPLE injection moulded prismatic materials

3.14
separate-performance material

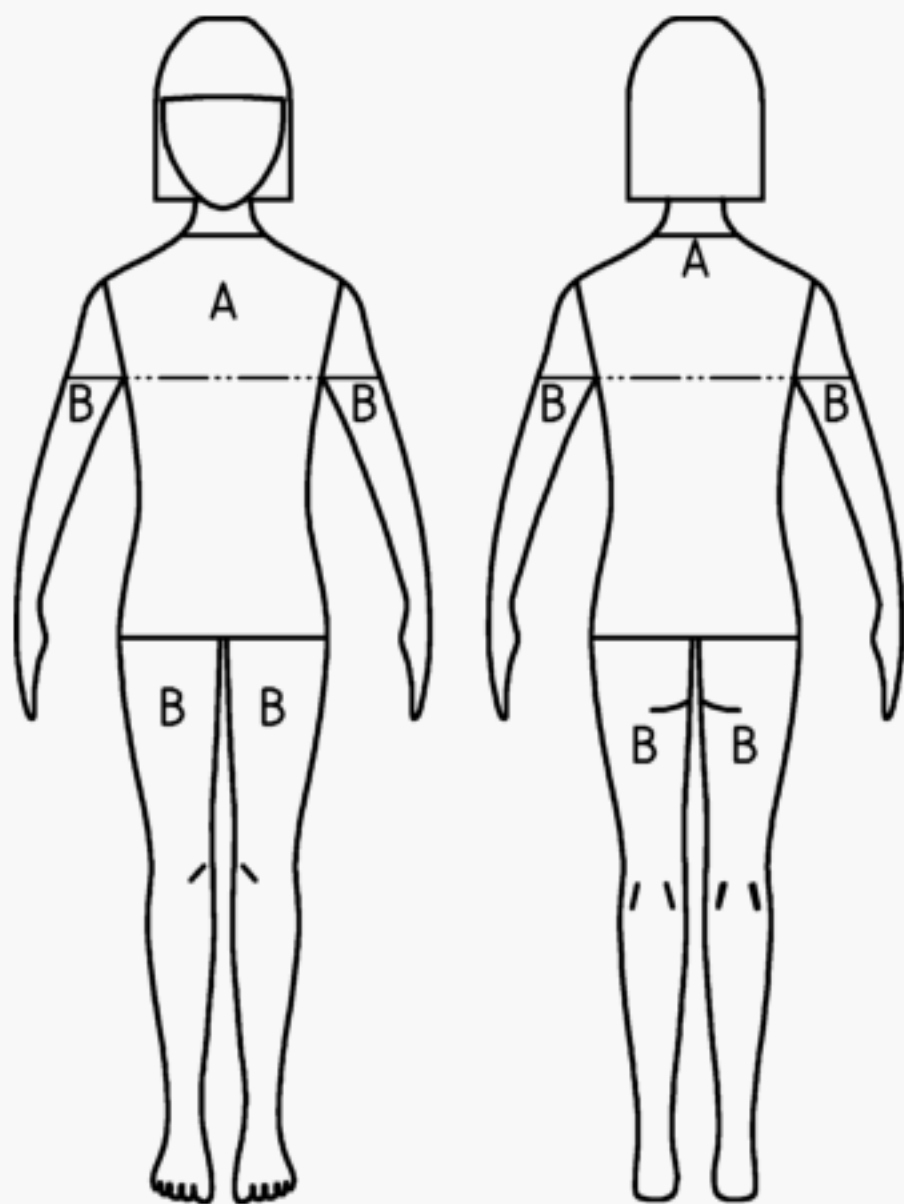
material intended to exhibit either fluorescent or retroreflective properties but not both

Note 1 to entry: “Fluorescent material” is defined as “background material” in EN ISO 20471:2013.

[SOURCE: EN ISO 20471:2013, 3.5]

3.15
torso
thorax and abdomen or section of the torso to which the limbs and neck are attached

Note 1 to entry: See Figure 1.



Key
A torso
B limbs

NOTE The area of B above the dotted line is considered as upper arm.

Figure 1 — Torso and limbs

[SOURCE: EN ISO 20471:2013, 3.8 - modified]

3.16
twilight
period in the morning or, in the evening during which the sun is below the horizon, either from daybreak to sunrise or from sunset to nightfall

4 Types and minimum area requirements

4.1 Types

The enhanced visibility equipment is grouped into three types based on the foreseeable conditions of use:

— Type A

Equipment worn by users where the risk of not being seen exists only at daylight conditions. This equipment uses only the fluorescent material as enhanced visibility component.

— Type B

Equipment worn by users where risk of not being seen exists only at dark conditions. This equipment uses only the retroreflective material as enhanced visibility component.

Type B is subdivided in 3 levels, as below. The classification depends on the total area worn or on placement of the device on user’s torso and limbs:

- Type B1 includes free hanging retroreflective devices only; these devices are designed for movement recognition.
- Type B2 includes retroreflective devices or retroreflective material either temporarily or permanently placed on limbs only; these products are designed for movement recognition. As a minimum, the retroreflective material shall be positioned on the limbs as a separate removable device or shall be incorporated into clothing design on a permanent basis as a retroreflective element.
- Type B3 includes retroreflective material placed on torso or torso and limbs. These products are designed for form recognition, or form and movement recognition. Type B3 items shall not be a combination of permanently attached reflective material and removable reflective devices.

NOTE 1 Additional retroreflective or combined-performance materials can be incorporated into garments.

— Type AB

Equipment worn by users where risk of not being seen exists during daylight, twilight and dark conditions. This equipment uses the fluorescent as well as the retroreflective and/or combined performance materials as enhanced visibility components.

Table 1 shows the different types.

Table 1 — Types

| Type A Daylight | Type B Dark conditions | Type AB Daylight, twilight and dark conditions |
|--------------------------------------|--|---|
| Equipment using fluorescent material | Equipment using retroreflective material | Equipment using fluorescent material and retroreflective or combined performance material |
| | B1 (free hanging) | |
| | B2 (limbs) | AB2 |
| | B3 (on torso or torso and limbs) | AB3 |

NOTE 2 See Annex B for examples and drawings.

For each type, the relevant material requirements in Clause 6 shall be fulfilled in accordance to Clause 7.

4.2 Minimum area requirements

Each type shall have minimum areas of materials incorporated in the garment or equipment in accordance with:

- Table 2 as required by Type B1 and Type B2; or
- Table 3 as required by garment Type A, Type B3 and Type AB.

Table 2 — Minimum required areas of material in m² for Types B1 and B2

| | B1 ^a | B2 ^b |
|--|-----------------|-----------------|
| Retroreflective material | 0,003 | 0,018 |
| ^a Total area of both sides of a single device. ^b If devices, the total area of two devices, measured flat | | |

Table 3 — Minimum required areas of material in m² for Types A, B3 and AB

| | A | B3 | AB | A | B3 | AB |
|--|-------------------------|------|------|-------------------------|------|------|
| Height h of the user | h ≤ 140 cm ^a | | | h > 140 cm ^a | | |
| Fluorescent material | 0,14 | — | 0,14 | 0,24 | — | 0,24 |
| Retroreflective material | — | 0,06 | 0,06 | — | 0,08 | 0,08 |
| Combined performance material | — | — | 0,14 | — | — | 0,24 |
| ^a If the height range (interval figures as described in EN ISO 13688:2013) includes 140 cm (e.g. garment designed for height range from 138 cm to 142 cm), then the requirements as stated in the column “h > 140” apply. | | | | | | |

Additional fluorescent, retroreflective or combined-performance materials may be incorporated into garments.

NOTE The area of visibility material shown in Table 3 cannot be reduced below the minimum requirements by the application of logos, lettering, labels, etc.

5 Design requirements

5.1 Size designation

The size designation for garments shall be in accordance with the requirements of EN ISO 13688:2013.

5.2 Type A

5.2.1 General

Type A garments (including partial body protective clothing) shall in their design use at least the minimum amount of fluorescent material according to Table 3.

NOTE 1 Protective clothing items are worn to cover one or more parts of the body, examples of partial body protection are sleeves, aprons and chaps.

The areas shall be measured on the smallest garment size intended to be supplied, in each of the two height ranges specified in Table 3, with all fasteners adjusted to the smallest configuration possible and with the garment laying flat on a table.

Fluorescent material areas covered by any logos, lettering, labels etc., are not counted towards the total area.

NOTE 2 Conspicuity is best achieved by having well defined areas of fluorescent material. Fragmented or highly patterned areas are unsuitable.

5.2.2 Visibility from all sides

Type A garments shall be made up of fluorescent material on all sides to ensure 360° visibility (visibility from all sides). For upper body garments fluorescent material shall be evenly distributed around the torso and/or upper arms and/or limbs, if any.

For lower body garments, fluorescent material shall be evenly distributed around the legs.

Visibility from all sides shall be reached as follows:

- not less than 40 % of the minimum required amount of fluorescent material specified in Table 3 is present on both the front and the back when laid flat, and
- not less than 10 % of the minimum required amount of fluorescent material specified in Table 3 is present on both the right and left sides when laid flat on the back (respectively on the front).

Annexes C and D show examples of designs and how to measure visibility from all sides.

5.3 Type B

5.3.1 General

These garments or devices shall in their design use at least the minimum amount of retroreflective material according to Table 2 or Table 3.

5.3.2 Type B1 – Free hanging devices

The devices shall be removable.

The total area of the devices in use shall meet the requirements in Table 2.

A Type B1 device shall be retroreflective from both sides.

Its optical active area shall be a minimum 15 cm² per side. The total area shall be maximum 50 cm² per side. In order to achieve 360° visibility (visibility from all sides) at least two devices shall be used, these shall be used on the left and the right side of the torso. This shall be specified in the user information.

The device shall be flat and its maximum thickness shall be 10 mm.

The means of attachment (string, ribbon, cord, spiral, etc.) shall be a minimum 10 cm, in length between the points of attachment on the garment and that on the reflector to enable free movement of the device around its vertical axis and allow a pendulum effect.

NOTE Consider additional requirements applicable for children’s products.

5.3.3 Type B2 – Equipment for limbs

The minimum area of retroreflective material shall fulfil the requirements in Table 2.

To ensure 360° visibility (visibility from all sides), one or more devices shall be applied to each upper and/or each lower limb.

When retroreflective material is applied to a garment it shall also be positioned to achieve 360° visibility (visibility from all sides). The material shall be placed on the limbs so as to ensure a minimum width of 20 mm encircling each limb.

Any gap in the lengthwise continuity of the retroreflective material shall not be greater than 50 mm, measured parallel to the direction of the material, and the total of such gaps shall not be greater than 50 mm around the limbs. Any offset not greater than the width of the material plus 5 mm is allowed.

Additionally, separate retroreflective elements may form part of an applied design in conjunction with the above. The retroreflective elements shall have a minimum area of 25 cm² each.

In the case of B2 garments covering upper and lower limbs, the retroreflective material can be applied on the upper limbs only, on the lower limbs only or on both the upper and lower limbs. In the latter case, the minimum amount of Table 2 shall be used for upper limbs and also for the lower limbs.

NOTE An example of a B2 garment is shown in Annex E.

5.3.4 Type B3 – Equipment for the torso or the torso and limbs

The minimum area of retroreflective material shall fulfil the requirements in Table 3. Garments and devices shall be measured flat and in their smallest configuration.

Retroreflective material shall be placed on the torso so as to ensure a minimum width of 20 mm encircling the torso. Alternatively, retroreflective materials may be placed to encircle the upper arms.

If a B3 garment covers limbs below the elbows or knees, then retroreflective material on the limbs is required. In this case, Type B2 requirements (see 5.3.3) for the limbs shall be fulfilled whilst the

remainder of the material shall be placed on the torso. It is not necessary for a minimum 20 mm wide band to be applied on the limbs in this case.

Additionally, separate retroreflective elements may form part of an applied design in conjunction with the above. The retroreflective elements shall have a minimum area of 25 cm² each.

NOTE Examples of Type B3 garments are reported in Annex E.

Visibility from all sides shall be reached as follows:

- not less than 40 % of the minimum required amount of retroreflective material specified in Table 3 is present on both the front and the back when laid flat, and
- not less than 10 % of the minimum required amount of retroreflective material specified in Table 3 is present on both the right and left sides when laid flat on the back (respectively on the front).

Any gap in the lengthwise continuity of the retroreflective material shall not be greater than 50 mm, measured parallel to the direction of the material, and the total of such gaps shall not be greater than 100 mm around the torso. Any offset not greater than the width of the material plus 5 mm is allowed.

In the case of B3 garments covering the torso, and the upper and lower limbs, the retroreflective material can be applied on the torso and the upper limbs only, on the torso and lower limbs only or on both the torso and the upper and lower limbs. In the latter case, the minimum amount of Table 2 shall be used for upper limbs and also for the lower limbs.

5.4 Type AB

These garments shall in their design use the minimum amount of fluorescent material and retroreflective material or combined performance material of appropriate group according to Table 3. Design requirements for Type AB clothing shall follow the same rules in terms of distribution of fluorescent material as applied to Type A in 5.2.

Design requirements for Type AB clothing shall follow the same rules in terms of distribution of reflective material as applied to Type B2 as in 5.3.3 or Type B3 in 5.3.4.

Combined performance material shall be used only in a form that maintains a width of ≥ 20 mm.

When using combined performance material, the area of fluorescent material can be reduced by the amount of combined performance material used.

6 Material requirements

6.1 Requirements for non-fluorescent material, fluorescent material and combined performance material

6.1.1 Colour performance requirements of new material

The colour and the luminance factor of new fluorescent and combined performance material shall be within the regions given in Table 4 when tested in accordance with 7.2.

Table 4 — Colour coordinates for fluorescent material and combined performance material

| Colour | Chromaticity coordinates | | Minimum luminance factor β_{\min} | |
|---------------------------|--------------------------|-------|---|-------------------------------|
| | x | y | Fluorescent material | Combined performance material |
| Fluorescent yellow-green | 0,201 | 0,776 | 0,5 | 0,4 |
| | 0,387 | 0,610 | | |
| | 0,356 | 0,494 | | |
| | 0,285 | 0,441 | | |
| Fluorescent yellow | 0,356 | 0,494 | 0,7 | 0,7 |
| | 0,387 | 0,610 | | |
| | 0,460 | 0,540 | | |
| | 0,398 | 0,452 | | |
| Fluorescent yellow-orange | 0,427 | 0,493 | 0,6 | 0,5 |
| | 0,460 | 0,540 | | |
| | 0,545 | 0,454 | | |
| | 0,494 | 0,426 | | |
| Fluorescent orange | 0,494 | 0,426 | 0,5 | 0,4 |
| | 0,545 | 0,454 | | |
| | 0,610 | 0,390 | | |
| | 0,535 | 0,375 | | |
| Fluorescent orange-red | 0,535 | 0,375 | 0,4 | 0,4 |
| | 0,610 | 0,390 | | |
| | 0,655 | 0,345 | | |
| | 0,570 | 0,340 | | |
| Fluorescent red | 0,570 | 0,340 | 0,25 | 0,25 |
| | 0,655 | 0,345 | | |
| | 0,690 | 0,310 | | |
| | 0,595 | 0,315 | | |
| Fluorescent pink | 0,690 | 0,310 | 0,3 | 0,3 |
| | 0,495 | 0,155 | | |
| | 0,372 | 0,272 | | |
| | 0,415 | 0,315 | | |

6.1.2 Colour after Xenon test

The colour after exposure shall be within the areas defined by the coordinates in Table 4 for fluorescent materials and combined performance materials and its luminance factor shall comply with the minimum value for the luminance factor (see Table 4) of the colour that is obtained on exposure to Xenon light e.g. a fluorescent red is acceptable if after exposure to Xenon light its colour-coordinates are within the tolerated area for orange-red and if its luminance factor is higher than 0,4. The exposure of the test sample shall be performed in accordance with EN ISO 105-B02:2014, method 3. Exposure shall continue until the blue scale control standard number 5 has changed to grade 3 of the grey scale for red and orange-red materials. For all other colours (yellow, pink, orange, yellow-orange, yellow green materials) the blue scale control standard number 4 has changed to grade 4 of the grey scale according to EN 20105-A02:1994.

If the colour changes from one colour box to another, this shall be mentioned in the instructions for use. The luminance factor shall meet the requirements of the new colour box.

6.1.3 Colour fastness of fluorescent material and all non-fluorescent material layers after test exposure

6.1.3.1 General

These requirements shall be applied only to Type A and Type AB equipment.

6.1.3.2 Colour fastness to rubbing

The test shall be conducted in accordance with EN ISO 105-X12:2016. The colour fastness to rubbing (dry), when assessed with EN 20105-A03:1994, shall be at least grade 4 of the grey scale with respect to staining.

6.1.3.3 Colour fastness to perspiration

The test shall be conducted in accordance with EN ISO 105-E04:2013. For fluorescent material, the colour fastness, when assessed with EN 20105-A02:1994, shall be at least grade 4 of the grey scale for the colour change of the specimen.

Fluorescent material and all non-fluorescent material layers, when assessed with EN 20105-A03:1994, shall be at least grade 4 of the grey scale with respect to staining.

6.1.3.4 Colour fastness when laundered, dry cleaned, hypochlorite bleached and hot pressed

According to the care recommendation of the garment, the colour fastness shall be determined in accordance with the performance requirements and test methods of Table 5.

Table 5 — Colour fastnesses

| Care process | Minimum fastness grade of the grey scale ^a | | Test method |
|--|---|---|---|
| | Fluorescent material | Non fluorescent material (without reflective and combined performance material) | |
| Laundry | Colour change: 4–5 | Staining: 4 | Domestic: EN ISO 105-C06:2010 ^b or Industry: EN ISO 105-C06:2010. Test number D1S |
| Dry cleaning | Colour change: 4 | Staining: 4 | EN ISO 105-D01:2010 |
| Hypochlorite bleaching | Colour change: 4 | — | EN 20105-N01:1995 |
| Hot pressing | Colour change: 4–5 | Staining: 4 | EN ISO 105-X11:1996 (condition dry/dry) |
| ^a According to EN 20105-A02:1994 and EN 20105-A03:1994. | | | |
| ^b According to care recommendations (see EN ISO 3758:2012). | | | |

Select only the fibre corresponding to the fibres of the fluorescent material and non-fluorescent material.

Specimens shall be line dried hanging in air at a temperature not exceeding 60 °C with parts in contact only at the lines of the stitching.

6.2 Dimensional change of fluorescent material and non-fluorescent material

Requirements and testing procedures for dimensional change on textile materials shall comply with EN ISO 13688:2013.

6.3 Photometric and physical performance requirements for the separate performance and combined performance materials

6.3.1 Retroreflective performance requirements of new material

The retroreflective components or devices shall meet requirements of area as well as retroreflection.

Type B1 devices shall meet the requirements of Table 6 in any colour. All other types and classes of equipment shall meet requirements of Table 7 or Table 8 as appropriate.

Measurements shall be made by the method specified in 7.3.

Orientation sensitive material, except for Type B1 devices, shall comply with the minimum photometric requirements stated in Table 7 or 8, as appropriate, at one of the two rotation angles specified in 7.3; and shall be not less than 75 % of the values stated in those tables, as appropriate, at the other rotation angle.

6.3.2 Type B1 – Free hanging devices

6.3.2.1 General

The device shall be measured on both sides, placed flat on the goniometer surface with the provision for attachment (mounting hole) pointed upwards just as in its intended wearing position. Each side shall fulfil requirements of Table 6.

Table 6 — Minimum Coefficient of Luminous Intensity RI (mcd lx^{-1}) for Type B1 devices

| Observation angle, α | Entrance angle, β | | |
|---|--|---|---|
| | $\beta_1 = 0^\circ$ $\beta_2 = \pm 5^\circ$ | $\beta_1 = \pm 10^\circ$ $\beta_2 = 0^\circ$ | $\beta_1 = 0^\circ$ $\beta_2 = \pm 20^\circ$ |
| 0,2° (12') | 560 | 350 | 280 |
| 0,33° (20') | 400 | 250 | 200 |
| 1,5° (1°30') | 20 | 10 | 10 |
| NOTE The photometric values in Table 6 are for any colour of Type B1 devices. | | | |

6.3.2.2 Flexible devices

A flexible device shall be identified as one that can be wrapped around a 25 mm mandrel 180° without any visible deformation of the material during or after the wrapping.

6.3.2.3 Rigid devices

A rigid device shall be identified as one that cannot be wrapped around a 25 mm mandrel 180°.

6.3.3 Type B2, B3 and AB – removable or permanently applied materials or devices

Retroreflective materials used in Type B2, B3 and AB devices or garments, shall meet Table 7 (for separate performance materials) or Table 8 (for combined performance materials).

Table 7 — Minimum Coefficient of Retroreflection R_A for separate performance retroreflective material ($\text{cd lx}^{-1}\cdot\text{m}^{-2}$) for Type B2, B3 and AB equipment

| Observation angle, α | Entrance angle, β_1 ($\beta_2 = 0$) | | | |
|---|---|-----|-----|-----|
| | 5° | 20° | 30° | 40° |
| 12' | 330 | 290 | 180 | 65 |
| 20' | 250 | 200 | 170 | 60 |
| 1° | 25 | 15 | 12 | 10 |
| 1°30' | 10 | 7 | 5 | 4 |
| NOTE Combined performance material exhibiting separate performance retroreflective properties can be classified as separate performance material for the purpose of complying with minimum required areas according to Table 3 (Type B3). | | | | |

Table 8 — Minimum Coefficient of Retroreflection R_A for combined performance reflective material ($\text{cd}\cdot\text{lx}^{-1}\cdot\text{m}^{-2}$) for Type AB equipment

| Observation angle, α | Entrance angle, β_1 ($\beta_2 = 0$) | | | |
|-----------------------------|---|-----|-----|------|
| | 5° | 20° | 30° | 40° |
| 12' | 65 | 50 | 20 | 5 |
| 20' | 25 | 20 | 5 | 1,75 |
| 1° | 5 | 4 | 3 | 1 |
| 1°30' | 1,5 | 1 | 1 | 0,5 |

6.4 Retroreflective performance requirements after test exposure

6.4.1 General

The samples tested in accordance with 7.3 shall be exposed as specified in Table 9 for Type B1 devices and Table 10 for Type B2 and B3 and Type AB equipment.

After exposure each test specimen of Type B1 devices shall fulfil the photometric requirements of Table 6.

After exposure each test specimen of Type B2 and B3 and Type AB equipment shall fulfil the photometric requirements of 6.4.2, 6.4.3 or 6.4.4, as applicable.

Table 9 — Test exposure for Type B1 devices

| Exposure instructions related to dimensions: Test specimens to be tested as they are. | Test sample rigid device | | | Test sample flexible device | | | | |
|--|--------------------------|---|---|-----------------------------|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 |
| 7.4.2. Folding at cold temperatures | | | | | x | | | |
| 7.4.3. Temperature variation | | | | | | x | | |
| 7.4.4. Influence of rainfall | | | | | | | x | |
| 7.4.5. Free fall test | | x | | | | | | |
| 7.4.6. Influence of water (water immersion) | | x | | | | | | |
| 7.3. Photometric testing | x | x | x | x | 0 | x | x | x |
| 0 = If, by observation, a sample cracks under test it shall be deemed to have failed the standard. | | | | | | | | |

Table 10 — Test exposure for Type B2 and B3 and Type AB

| Exposure | Devices | Garments |
|------------------------------|------------------|----------|
| Abrasion | 7.4.1 | 7.4.1 |
| Folding at cold temperatures | 7.4.2 | 7.4.2 |
| Temperature variation | 7.4.3 | 7.4.3 |
| Rainfall | 7.4.4 | 7.4.4 |
| Washing | [Not applicable] | 7.5.2 |
| Dry cleaning | [Not applicable] | 7.5.3 |

6.4.2 Separate performance material

The coefficient of retroreflection R_A for separate performance retroreflective materials shall exceed $100 \text{ cd}/(\text{lx} \cdot \text{m}^2)$ measured at observation angle $\alpha = 12'$ and entrance angle $\beta_1 = 5^\circ$ ($\beta_2 = 0^\circ$).

6.4.3 Combined performance material

The coefficient of retroreflection R_A for combined performance material shall exceed $30 \text{ cd}/(\text{lx} \cdot \text{m}^2)$ measured at observation angle $\alpha = 12'$ and entrance angle $\beta_1 = 5^\circ$ ($\beta_2 = 0^\circ$). When determining the influence of rainfall in accordance with 7.4.5, coefficient of retroreflection shall exceed $15 \text{ cd}/(\text{lx} \cdot \text{m}^2)$.

6.4.4 Orientation sensitive materials

The coefficient of retroreflection R_A for orientation sensitive material after exposure shall comply with the same requirements of 6.4.2 or 6.4.3, as appropriate, at one of the two orientations specified in 7.3.3 and shall be not less than 75 % of those required values at the other orientation.

7 Test methods

7.1 Sampling and conditioning

Samples for testing shall be taken from the original device or from the retroreflective or fluorescent material as used in the garment or a device. The size, shape and quantity shall be as required for each test procedure.

Unless otherwise specified, one specimen of each material shall be tested and shall comply with the minimum requirements before and after exposure.

The specimens shall be conditioned for at least 24 h at $(20 \pm 2)^\circ\text{C}$ and $(65 \pm 5)\%$ relative humidity. If the test is carried out in other conditions, the test shall begin within 5 min after withdrawal from the conditioning atmosphere.

7.2 Determination of colour

The colour shall be measured in accordance with the procedures defined in CIE 015:2018, using an instrument with polychromatic illumination (CIE D65 illuminant).

The instrument shall have a 45/0 illuminating and viewing geometry. The colour coordinates shall be determined using CIE standard illuminant D65 and 2° standard observer (CIE 1931 = standard colorimetric observer). The specimen shall be measured with a single layer including any backing or lining used in its constructions and backed by a black underlay with a reflectance of less than 0,04. At

least four measurements shall be carried out in four perpendicular directions and the mean value shall be given as the test result.

NOTE If the instrument is known to be either an annular or circumferential type, only one reading can be performed

7.3 Method of determination of retroreflective photometric performance

7.3.1 General

The photometric performance shall be determined in accordance with the procedure defined in CIE 54.2:2001.

7.3.2 Type B1 devices

Samples for measurement shall consist of the original device. Each colour shall be tested separately.

When a family of devices is manufactured, testing can be performed only on the smallest presented product and on the colour with the lowest photometric values.

For the other products, only the optical active area shall be calculated and be larger than the one of the approved product.

All area covered by print that influence the performance of the final product shall be treated as non-retroreflective even if it is transparent colours and deducted from the total area.

7.3.3 Type B2 and B3 and Type AB devices or garments

Samples for measurement shall consist of one piece of retroreflective material (100 × 100) mm or multiple retroreflective elements as used on finished garment or device, combined and mounted flat side by side as close as possible to form an area of (100 × 100) mm or width of the item in a length of 10 cm or in size of specimen of the exposure treatment.

If the retroreflective elements exhibit the presence of logos or printings or other cosmetic enhancements, the selection of the retroreflective element shall be made on the lowest performing segment with respect to the retroreflective performance. If it is determined that no such logos or printings or custom markings exist, the selection of samples shall be made at random.

The lowest performing segment shall be identified visually and confirmed by preliminary photometric assessments. Each of the segments combined to form an area of (100 × 100) mm shall consist of the lowest performing segment.

R_A for the sample shall be measured at two positions of the rotation angle ε , 0° and 90° and at an observation angle of 12' with an entrance angle of 5°. The position 0° is determined by one of the following means:

- a clear datum mark on each sample;
- a clear instruction given by the manufacturer of the material;
- If no mark or instruction exists, the position $\varepsilon = 0^\circ$ can be chosen at random.

7.4 Test exposure of retroreflective material

7.4.1 Abrasion

The test sample shall be abraded in accordance with EN ISO 12947-2:2016, using the wool fabric abradant at a pressure of 9 kPa. The specimen shall be placed on the abradant table and the abradant shall be mounted in the test piece holder.

The specimens shall be measured after 5 000 cycles.

NOTE Regarding EN ISO 12947-2:2016, the inverted mode (i.e. the specimen placed on the abradant table instead of in the test piece holder and the abradant mounted in the test piece holder) provides an abraded area which allows post-abrasion testing or evaluation to be carried out.

7.4.2 Folding at cold temperatures

The test sample shall be exposed and folded in accordance with ISO 4675:2017 at a temperature of $(-20 \pm 2) ^\circ\text{C}$.

After reconditioning to the atmosphere in accordance with 7.1 for at least 2 h. No cracking or loss of surface material is permitted.

7.4.3 Exposure to temperature variation

Two stripes of reflective tape of 100 mm length and the width of the tape shall be exposed continuously to a cycle of changing temperatures:

- a) for 12 h at $(50 \pm 2) ^\circ\text{C}$; immediately followed by
- b) 20 h at $(-30 \pm 2) ^\circ\text{C}$ and
- c) conditioned for at least 2 h in accordance with 7.1.

The specimen is cut after pre-treatment to size (100×100) mm for the retroreflection test.

7.4.4 Rainfall

The sample shall be tested in accordance with EN ISO 20471:2013, 7.4.5.

7.4.5 Free fall test

See EN 60068-2-31:2008. The sample shall be conditioned at the temperature of $(-30 \pm 2) ^\circ\text{C}$ for 4 h. Immediately after, the sample is dropped down onto a steel plate from the height of 0,5 m. The test shall be repeated ten times.

After the test the sample shall meet 7.3 and 7.4.6. During the free fall test the sample is without hanging and fixing elements if they are separable from the retro-reflector unit.

7.4.6 Influence of water (water immersion)

The sample pretested according to 7.4.5 shall be immersed with one retroreflective side up into water with temperature $(50 \pm 5) ^\circ\text{C}$. The top point of the sample shall be minimum 20 mm under the surface of the water. After 10 min the sample is turned around so that the other side is turned down. Allow it to stay for another 10 min. The sample is immediately hereafter transferred to another basin with temperature $(25 \pm 5) ^\circ\text{C}$, and the procedure is repeated.

Photometric measuring before and after the test gives basis for determination of any occurred changes. The measuring is done 15 min after having removed sample from water and hanging it vertically.

7.5 Ageing

7.5.1 General

When the manufacturer's instructions give a maximum number of cleaning cycles, the requirements of Table 4 for fluorescent materials and 6.4.2, 6.4.3 and 6.4.4 for retroreflective materials shall be met after the maximum number of cleaning cycles indicated by the manufacturer. If the number of cleaning cycles is not specified, the tests shall be carried out after five cleaning cycles.

If the manufacturer’s instructions indicate that cleaning is not allowed, i.e. single-use then testing shall be carried out on new material only.

NOTE Manufacturers’ instructions typically indicate one or several of the various methods and processes of EN ISO 3175, EN ISO 6330:2012, ISO 15797:2017 or equivalent as standardized processes for cleaning.

7.5.2 Washing

Wash in accordance with the manufacturer’s instructions.

Samples for testing shall be taken from the original garment or device, or shall be representative of the component. Alternatively, for domestic laundering of retroreflective materials, one material specimen measuring (300 × 250) mm shall be prepared with two stripes of retroreflective material, each (250 × 50) mm, with a distance between the two stripes of 50 mm.

The test samples shall be washed in accordance with the manufacturer’s instructions. A wash cycle consists of washing and drying.

7.5.3 Dry cleaning

Samples shall be prepared in accordance with 7.5.2.

The test sample shall be dry cleaned in accordance with the manufacturer’s instructions.

8 Marking

For garments, the marking requirements defined in EN ISO 13688:2013 shall be met. The devices shall be marked with the following:

- a) name of the manufacturer and address;
- b) number and year of this document;
- c) type of equipment.

If a maximum number of cleaning cycles is stated in the manufacturer’s instructions, this number shall be related to the component of the enhanced visibility material with the lowest number of washes.

If applicable, the maximum number of washes shall be marked on the equipmen’s label near to the graphical symbol.

All products shall be marked with the symbols according to Figure 2, indicative of daylight and/or dark conditions of use.

The marking of the device shall be on the product itself or if not possible on labels attached to the product or to the smallest packaging unit.

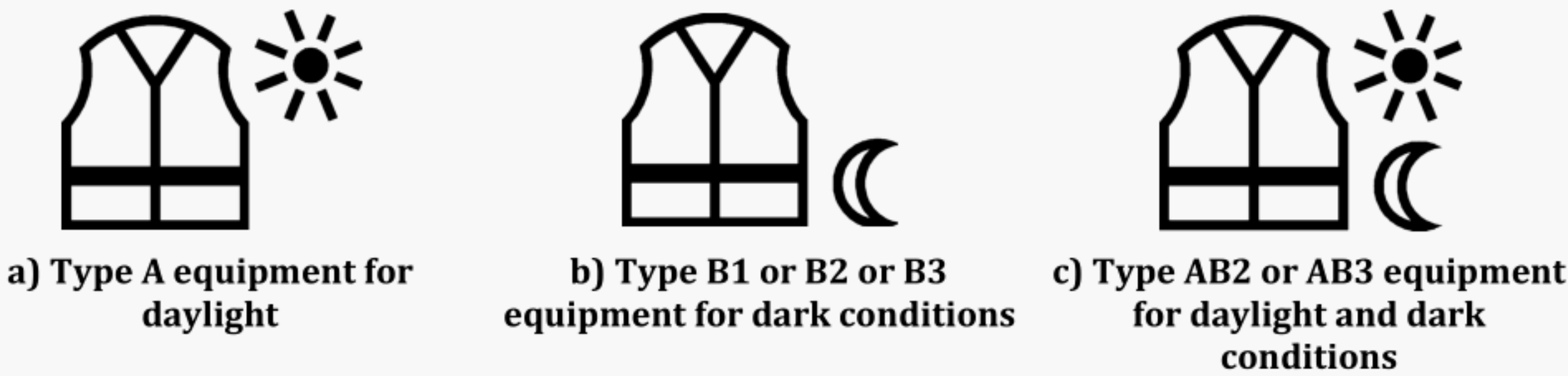


Figure 2 — Enhanced visible equipment

9 Information supplied by the manufacturer

For garments, the requirements for information supplied by the manufacturer shall be in accordance with EN ISO 13688:2013. The following sentences shall be included in the information supplied by the manufacturer (if applicable):

- a) “When relevant, the stated maximum number and type of cleaning cycles is not the only factor related to the lifetime of the garment.

The lifetime depends on usage, care storage, and also, if relevant, on the number of cleaning cycles.”

- b) “For B1 devices, in order to achieve 360° visibility (visibility from all sides) at least two B1 devices shall be used; these shall be used on the left and the right side of the torso.”
- c) “For B2 devices, in order to achieve 360° visibility (visibility from all sides) at least two B2 devices shall be used; these shall be used on the left and the right side of the torso.”
- d) “Any alterations of the product such as printing of logos may compromise the minimum areas and performance of the product”

If the colour after the Xenon test changes from one colour box to another, this shall be mentioned in the instructions for use.

Annex A
(informative)

Examples of garments or devices according to types and classes

NOTE Table A.1 is from EN ISO 20471:2013

Table A.1 — Factors related to the risk level

| Risk level | Factors related to the risk level ^a | | Risk level | |
|--------------------------------------|--|-------------------|------------------------|--|
| | Vehicle speed | Type of road user | | |
| High risk EN ISO 20471 class 3 | > 60 km/h | Passive | High visibility | <ul style="list-style-type: none">— day and night visibility— 360° (visibility from all sides)— design for form recognition— encircling the torso— quantity and quality for day and night |
| High risk EN ISO 20471 class 2 | ≤ 60 km/h | Passive | | |
| High risk EN ISO 20471 class 1 | ≤ 30 km/h | Passive | | |
| Medium risk | ≤ 60 km/h | Active | Enhanced visibility | <ul style="list-style-type: none">— day and night visibility— visibility from all sides— design for movement recognition if applicable (not necessarily encircling the torso)— quantity and quality for day and night (not necessarily EN ISO 20471)— more freedom in colours and design |
| | ≤ 15 km/h | Passive | | <ul style="list-style-type: none">— night visibility— visibility from all sides— design for movement recognition if applicable (not necessarily encircling the torso)— quantity and quality for night (not necessarily EN ISO 20471)— no “gadgets” |
| | ≤ 60 km/h | Active | | |


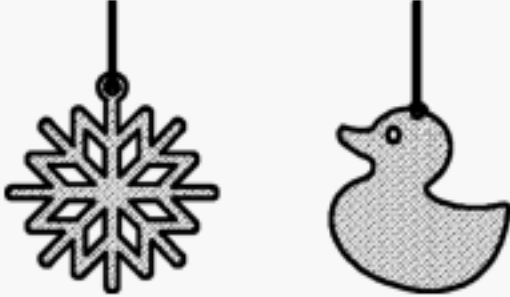




| Risk level | Factors related to the risk level ^a | | Risk level | |
|---|--|-------------------|------------|--|
| | Vehicle speed | Type of road user | | |
| Low risk | - | - | Visibility | <ul style="list-style-type: none">— bright colour— piping and/or randomly designed reflective material— any quantity and quality |
| ^a Depending on local issues such as weather conditions, background contrast, traffic density and other factors, one of these factors may lead to a higher level. | | | | |

Low risk is understood not to signal the user’s presence visually, i.e. when using visibility material for decoration or design.

Annex B
(informative)

Examples of different types of equipment

Table B.1 — Drawings and examples of garments or devices

| daylight conditions | dark conditions | | daylight conditions and dark conditions |
|---|--------------------------|--|--|
| <p>Type A: T-shirts, vests, jackets, trousers, tabards</p>  | free hanging devices | <p>Type B1: Dangle tags</p>  | |
| | limbs only | <p>Type B2: Arms/leg bands, trousers with reflective in the legs only, long sleeve garments with reflective in the sleeves only</p>  | <p>Type AB2: T-shirts, vests, jackets, trousers, tabards</p>  |
| | torso or torso and limbs | <p>Type B3: T-shirts, vests, jackets, coverall tabards</p>  | <p>Type AB3: T-shirts, vests, jackets, tabards</p>  |
| The dotted area describes the fluorescent area of the product | | | |

Annex C
(informative)

Examples on how to determine visibility from all sides for Type A garments

The hatched area describes the fluorescent area of the garment.

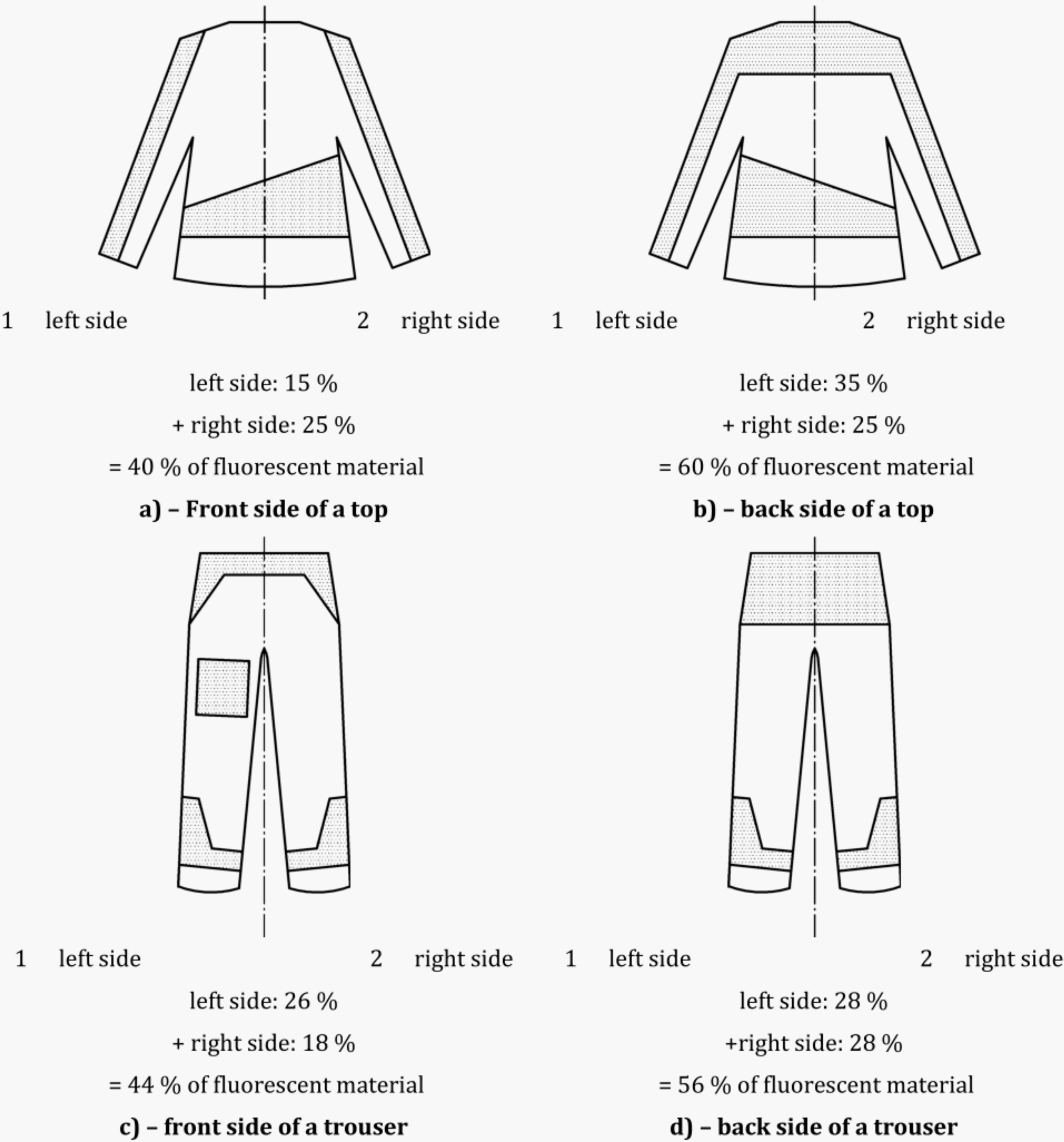


Figure C.1 — Examples on how to prove visibility from all sides

Annex D
(informative)

Possible designs for the placement of fluorescent material on garments

Figure D.1 shows examples of possible designs for the placement of fluorescent material (light grey area).

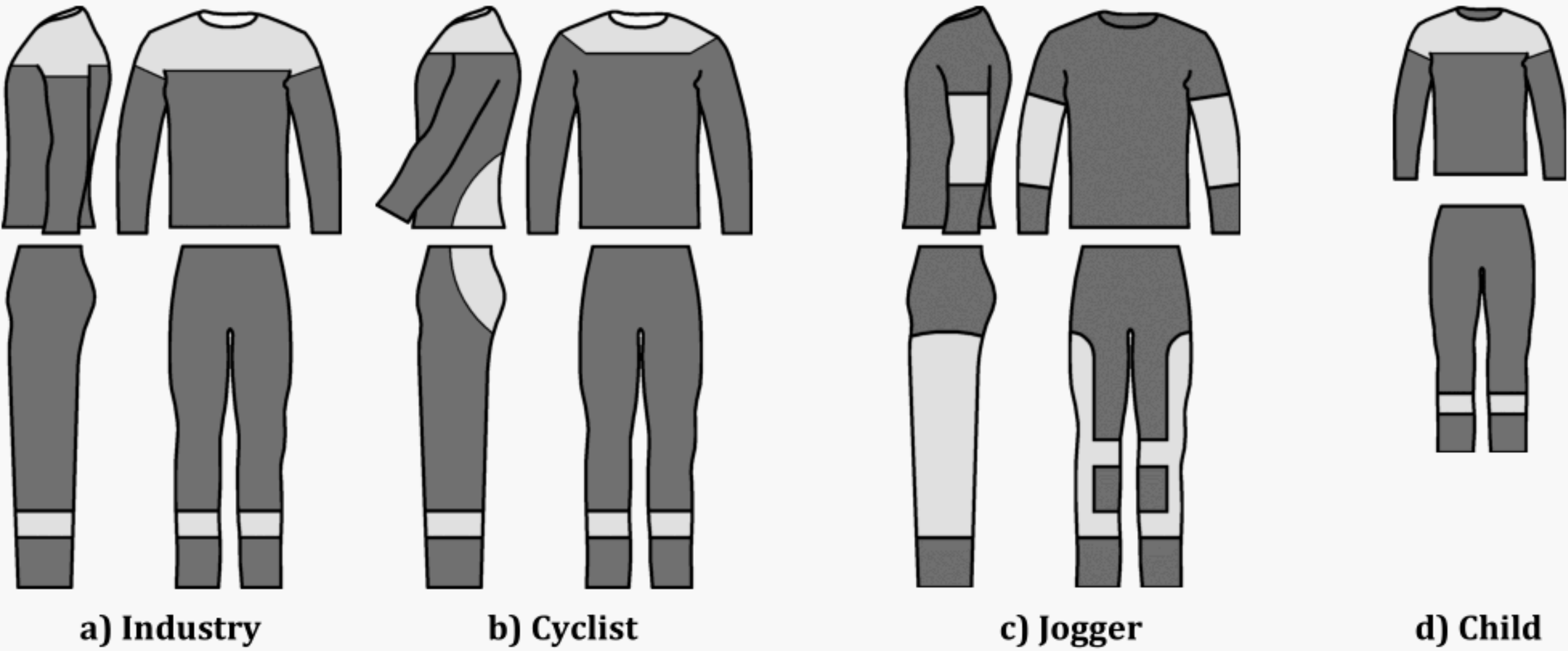


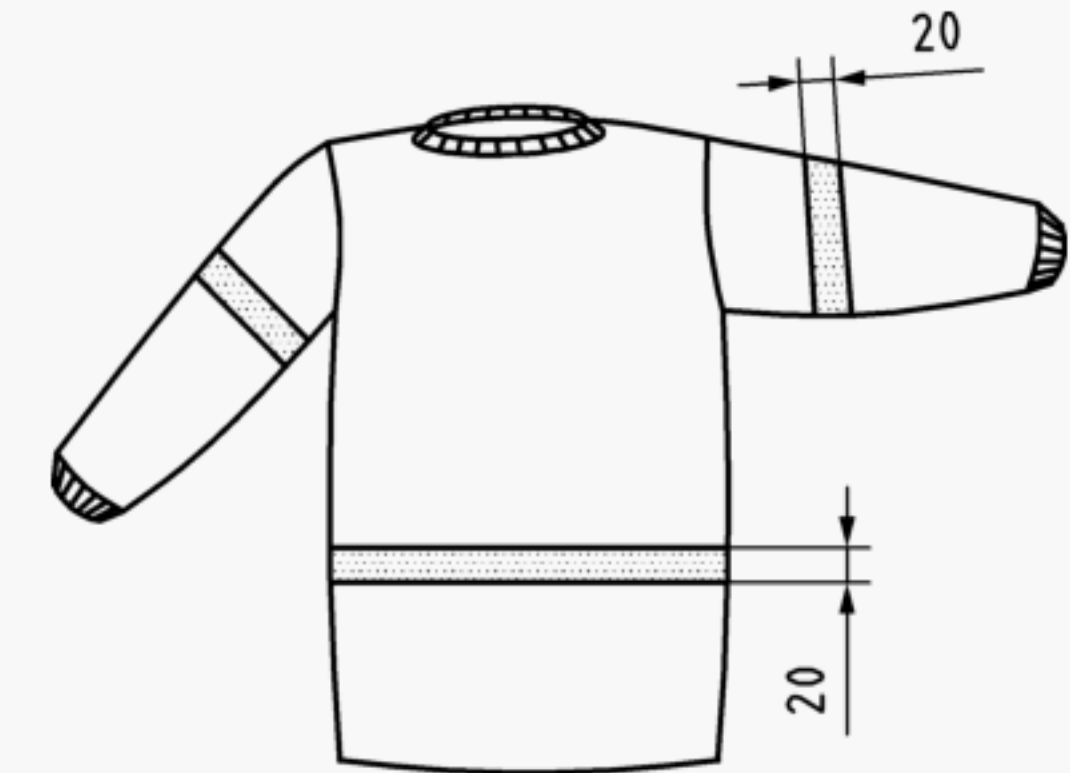
Figure D.1 — Examples of possible designs for the placement of fluorescent material

Annex E
(informative)

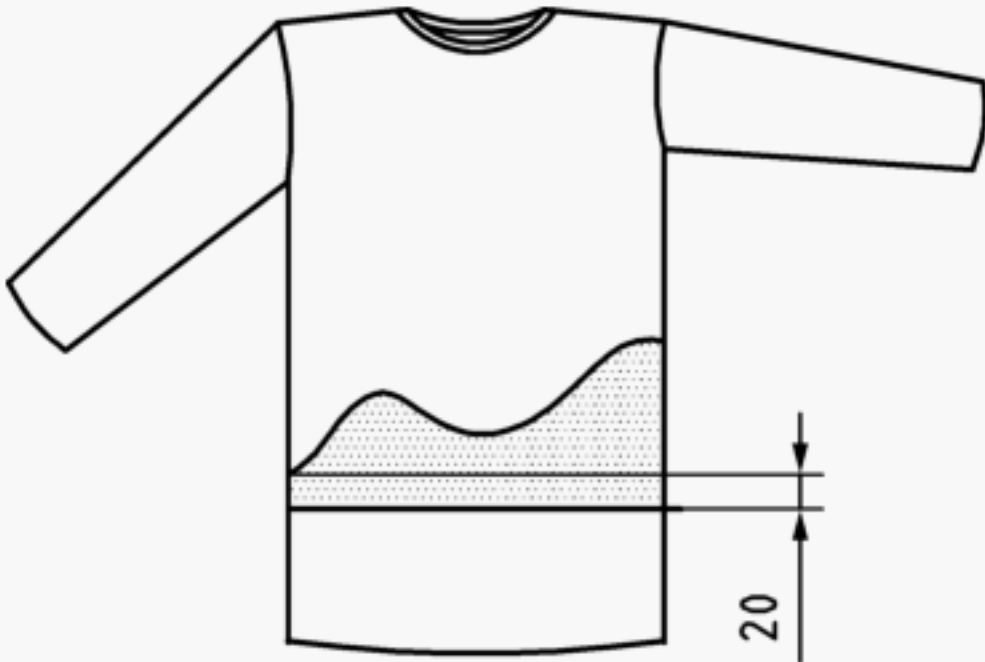
Examples of Type B2 and Type B3 garment

The grey hatched area shows possible designs for the retroreflective area of the garment.

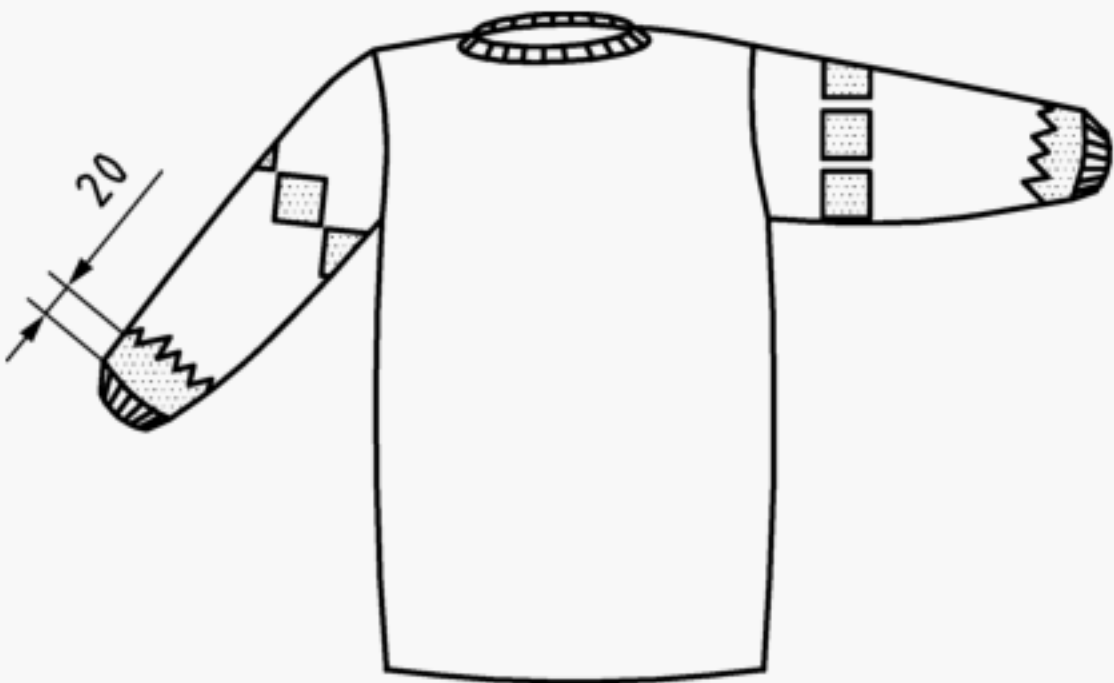
Dimensions in millimetres



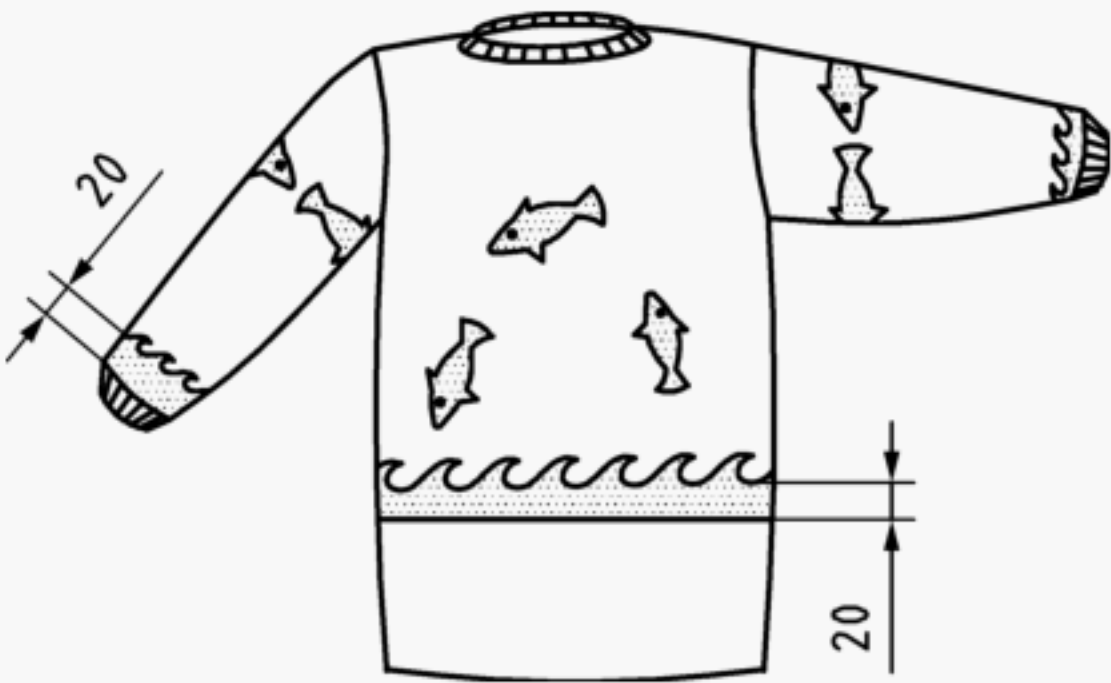
a) Examples of Type B3 garment using only stripes



b) Example of Type B3 garment with material positioned with a minimum width of 20 mm, the rest positioned to give visibility from all sides



c) Example of Type B2 garment with material positioned with a minimum width of 20 mm, the rest positioned to give visibility from all sides



d) Example of Type B3 garment with material positioned with a minimum width of 20 mm, the rest positioned to give visibility from all sides

Figure E.1 — Examples of Type B2 and Type B3 upper garments

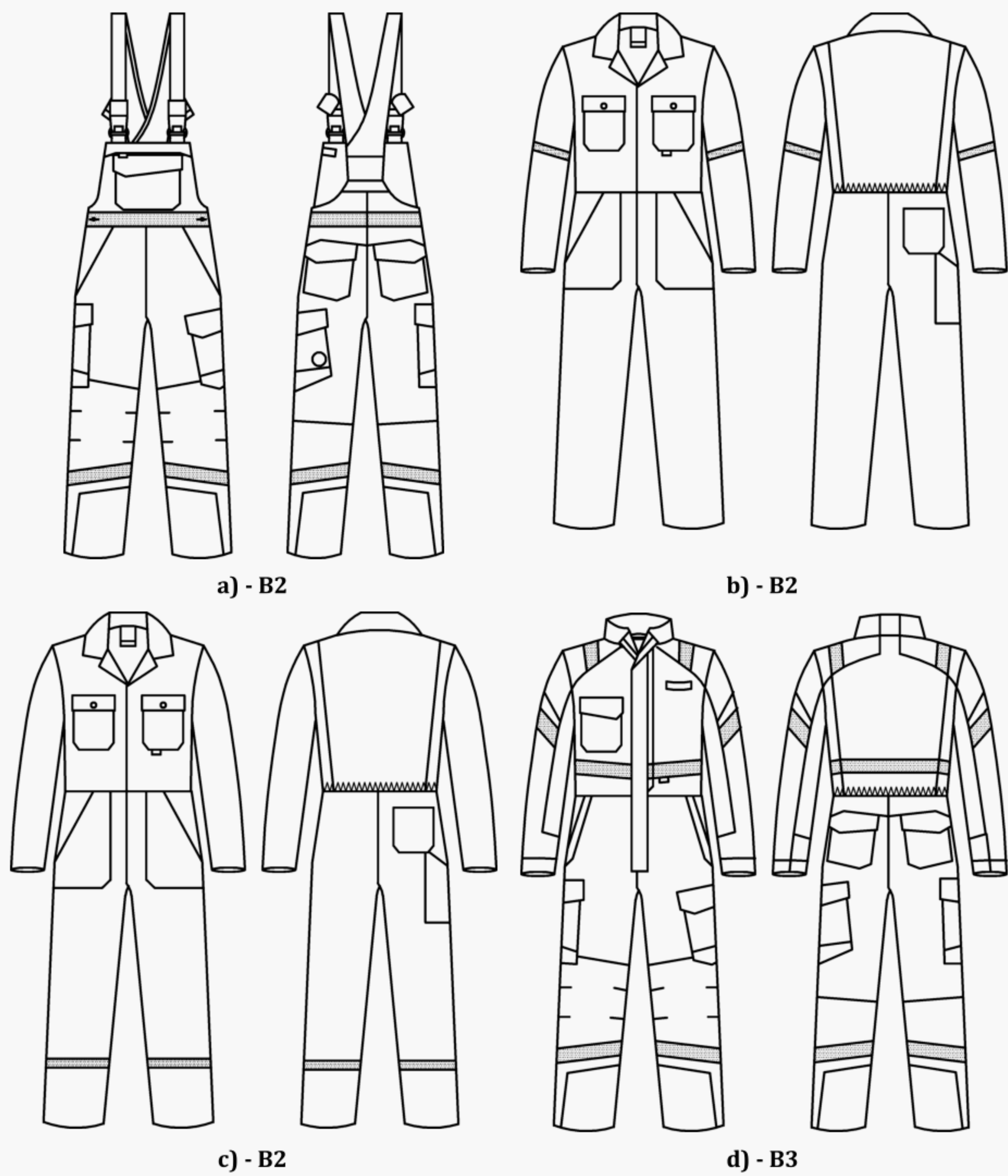


Figure E.2 — Examples of Type B2 and Type B3 coveralls

Annex ZA
(informative)

Relationship between this European Standard and the essential requirements of Regulation 2016/425 aimed to be covered

This European Standard has been prepared under a Commission’s standardization request to provide one voluntary means of conforming to essential requirements of Regulation (EU) 2016/425 of the European Parliament and of the Council of 9 March 2016 on personal protective equipment and repealing Council Directive 89/686/EEC.

Once this standard is cited in the Official Journal of the European Union under that Regulation, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Regulation, and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Regulation 2016/425

| Essential Requirements of Regulation | Clause(s)/subclause(s) of this EN | Remarks/Notes |
|--|-----------------------------------|---------------|
| 1.1.2.2. Classes of protection appropriate to different levels of risk | 4.1 | |
| 1.2.1. Absence of inherent risks and other nuisance factors | 4.1, 4.2, 5.2, 5.3, 5.4, 6.2 | |
| 1.3.2 Lightness and strength | 6.1.2, 6.1.3, 6.4 | |
| 1.4. Manufacturer’s instructions and information | 8, 9 | |
| 2.4. PPE subject to ageing | 7.5 | |
| 2.12. PPE bearing one or more identification markings or indicators directly or indirectly relating to health and safety | 8 | |
| 2.13. PPE capable of signalling the user’s presence visually | 6.1.1, 6.3.1, 6.3.2, 6.3.3 | |

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

Bibliography

- [1] EN 71-1:2014+A1:2018, *Safety of toys - Part 1: Mechanical and physical properties*
- [2] EN ISO 3758:2012, *Textiles - Care labelling code using symbols (ISO 3758:2012)*
- [3] EN ISO 6330:2012, *Textiles - Domestic washing and drying procedures for textile testing (ISO 6330:2012)*
- [4] EN ISO 7854:1997, *Rubber- or plastics-coated fabrics - Determination of resistance to damage by flexing (ISO 7854:1995)*
- [5] EN ISO 15797:2018, *Textiles - Industrial washing and finishing procedures for testing of workwear (ISO 15797:2017)*
- [6] ISO 3175-1:2017, *Textiles - Professional care, drycleaning and wetcleaning of fabrics and garments - Part 1: Assessment of performance after cleaning and finishing*
- [7] ISO 3175-2:2017, *Textiles - Professional care, drycleaning and wetcleaning of fabrics and garments - Part 2: Procedure for testing performance when cleaning and finishing using tetrachloroethene*
- [8] ISO 3175-3:2017, *Textiles - Professional care, drycleaning and wetcleaning of fabrics and garments - Part 3: Procedure for testing performance when cleaning and finishing using hydrocarbon solvents*
- [9] ISO 3175-4:2018, *Textiles - Professional care, drycleaning and wetcleaning of fabrics and garments - Part 4: Procedure for testing performance when cleaning and finishing using simulated wetcleaning*
- [10] ISO 7000, *Graphical symbols for use on equipment - Registered symbols*

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