



Safety Apparel Overview

ANSI Made Easy
A White Paper for Quick Reference



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ANSI/ISEA 107-2010 Made Easy

A Quick Reference to High-Visibility Safety Apparel

The American National Standard for High-Visibility Safety Apparel and Headwear (ANSI/ISEA 107-2010) is a standard established by American National Standards Institute, Inc. Construction, maintenance, utility, emergency responders, airport ramp personnel and other workers are routinely exposed to the hazards of low visibility while on the job. This standard provides guidelines for the selection and use of high-visibility safety apparel such as shirts, rainwear, outerwear, safety vests and headwear to improve worker visibility during the day, in low-light conditions and at night. Notable changes from the second edition (ANSI/ISEA 107-2004) include a new requirement for retroreflective material in the shoulder area; clarification of the definitions of waterproof, water resistant, and water repellant; and new labeling and test requirements for flame resistant garments. The appendices have been updated to include additional examples of garment designs and trim patterns such as split trim configurations.

This information, ANSI/ISEA 107-2010 Made Easy: A Quick Reference to High-Visibility Safety Apparel, summarizes the main provisions of the standard including minimum performance criteria and basic design requirements. You should obtain a copy of the standard and refer to it for more detailed information. And remember, there is more to designing a high-visibility safety garment than meeting the minimum performance specifications and design guidelines of the ANSI/ISEA 107-2010 standard. Garment designs should incorporate the full range of your needs for functionality, comfort, durability and image.

ANSI/ISEA 107 History and Related Regulations

The ANSI/ISEA 107-1999 standard was the first U.S. standard for the design and performance of materials for high-visibility safety apparel. Since 1999, private industry, various federal, state, and local authorities have embraced ANSI/ISEA 107 compliant garments and headwear as useful PPE for workers exposed to struck-by hazards. In November 2008, 23 CFR part 634 was the first U. S. Federal regulation applied to highway construction, maintenance and utility workers, and required the use of performance ANSI/ISEA 107 Class 2 or 3 garments. The 23 CFR part 634 regulation has been incorporated into the 2009 edition of the Federal Highway Administration's Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD requires all workers on or near the roadway right-of-way to wear high-visibility safety apparel that meets performance Class 2 or 3 of ANSI 107-2004 or equivalent revisions. The MUTCD cites two special cases.

1. In addition to ANSI 107, law enforcement personnel and other emergency responders may comply by using ANSI 207-2006 garments.
2. Fire fighters may use retroreflective turnout gear compliant to NFPA standards when exposed to flame, fire, heat and/or hazardous materials during emergency operations.

ANSI/ISEA 107-2010 specifies the following:

- Design
- Requirements for Background and Combined-Performance Retroreflective Materials
- Photometric and Physical Performance Requirements for Retroreflective Materials
- Care Labeling

Definitions

Retroreflective, combined-performance, and background materials must be certified to the specific performance requirements in the standard. High-visibility safety apparel manufacturers must make documentation available to verify that the finished garments also meet the requirements of the standard.

Background material: Colored fluorescent material intended to be highly conspicuous, but not intended to comply with the requirements of this standard for retroreflective material.

Retroreflective material: Material that reflects and returns a relatively high proportion of light in a direction close to the direction from which it came.

Combined-performance material: A retroreflective material that is also a fluorescent material. Combined-performance materials can be counted toward the minimum area requirements for background material specified in Table 1.

Compliance: Retroreflective, combined-performance and background materials are to be certified to the performance requirements in the standard. Manufacturers of the finished garment must make documentation available to verify that components used to make high-visibility garments meet the requirements of the standard.

Certify (background and retroreflective material): To obtain compliance certification documents based on testing from an independent, third party accredited laboratory to verify performance requirements as specified in the standard.

Certify (finished item): To provide documentation from either an independent third-party accredited laboratory or to self-certify through the use of the Apparel and Headwear Compliance Certificate. (Appendix D6)

Accredited laboratory: A laboratory having a certificate of accreditation meeting the requirements ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories* (or other equivalent standard) for the collection and analysis of data within the parameters of this standard.

Design

The ANSI/ISEA 107-2010 standard provides design guidelines and specifies the photometric requirements, minimum amounts of component materials, colors, and placement to create garments and headwear for the purpose of enhancing the visibility of workers. Refer to Section 6 of the standard for more detailed information. The selection of components and classes of apparel should be made based upon what is appropriate for the hazard and with the safety of the worker in mind.

Component Colors

There are three different colors for background and combined-performance material from which to choose: fluorescent yellow-green, fluorescent orange-red and fluorescent red. Users should consider the work and natural environment to determine the most conspicuous color for daytime use. Is the environment urban or rural, heavy foliage or desert? Are work zone devices and equipment yellow or orange? Choose the fluorescent color that achieves the highest degree of worker contrast.

Garment Classes

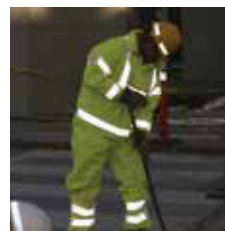
Three classes of high-visibility safety apparel help the user choose the proper garments for a work situation. The classes state the minimal amount of background and retroreflective material, and placement of retroreflective material needed as well as technical requirements for garment design. Garments that cover the torso, such as T-shirts and safety vests, are intended to meet Class 1 or Class 2 requirements. Shorts are included in the description of Class E garments.



Class 1 Garments



Class 2 Garments

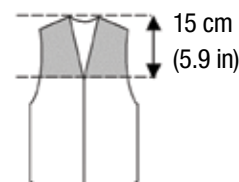


Class 3 Garments

Retroreflective Material Placement

Class 1 and 2 garments, such as vests and T-shirts, and Class 3 garment designs, such as vest with Class E pants ensembles, coveralls, outerwear and rainwear should achieve the following:

- Use of retroreflective band widths appropriate for the garment class. (Refer to Section 6.1.1. of the standard.)
- Provide 360° visibility with horizontal gaps of 50 mm or less.
- Garments without reflective material encircling the sleeves, are now required to have 150 cm² (23.25 in²) of reflective material in the shoulder area, to provide 180° visibility of the wearer. Shoulder area is defined as measuring 15 cm (5.9 in) down from the shoulder high point, on the front and back of the garment. The requirement of 23.25 in² is the total amount of reflective material required in the shoulder area including the front and back of the garment, e.g., shoulder area retroreflective material amount front + rear ≥ 23.25 in².
- Appropriate separation distances of vertical and horizontal bands placed on the torso, sleeves and trouser areas.
- Appropriate retroreflective band placement and garment design.
- In addition to trim, retroreflective patterns, such as logos, design icons, or identification text may contribute to the maximum area requirements specified in Table 1.



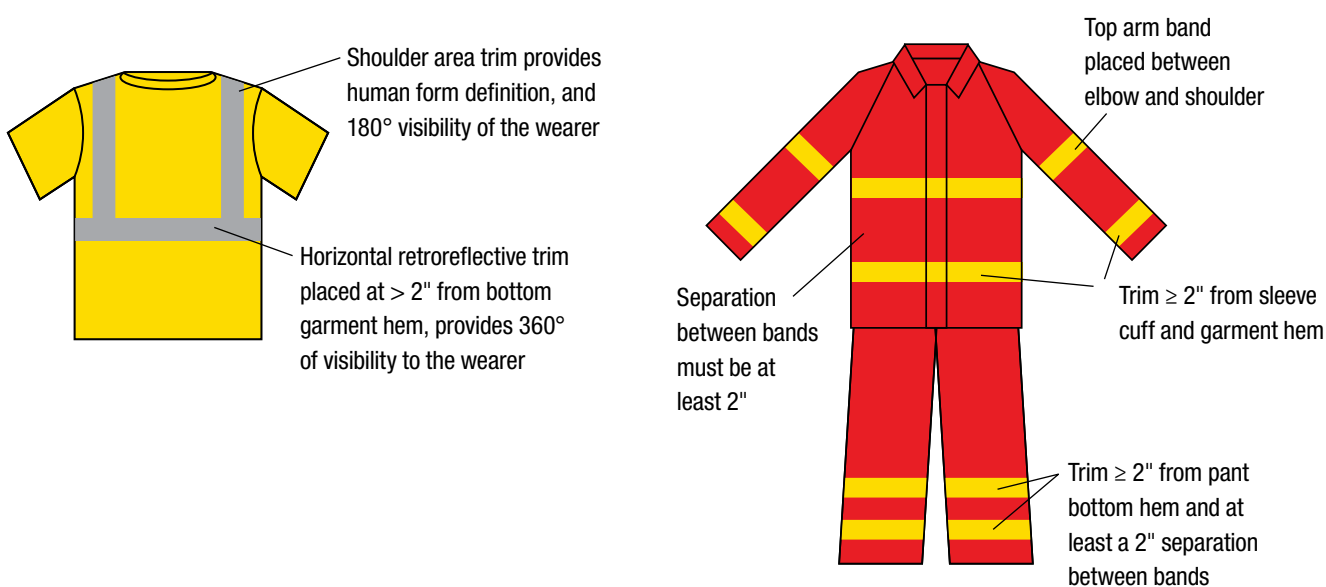
Requirements for Background and Combined-Performance Materials

Section 7 of the standard provides specifications for color, brightness, fabric strength and moisture resistance after various exposure tests.

- Background and Combined-Performance material needs to be tested for chromaticity or color, and luminance or brightness, when new and for colorfastness after laundering and Xenon (UV light) exposure. Table 2 in Section 6 is now the requirement for both background and combined-performance materials.
- Background materials must also be tested for colorfastness after crocking and perspiration tests.
- Other tests for background materials include testing for dimensional change (shrinking) after washing and dry-cleaning, tensile strength, tear resistance, bursting strength of woven material and bursting strength of knitted material.
- If the garment is intended to provide protection during rainfall, background materials also need to be tested as water repellent, water resistant, and /or water proof. See Section 7.5 of the standard for updated definitions.

Table 1: Minimum areas of visible material – ANSI/ISEA 107-2010					
	Performance Class 3	Performance Class 2	Performance Class 1	Class E	Headwear
Background material	1240 in ² (0.80 m ²)	775 in ² (0.50 m ²)	217 in ² (0.14 m ²)	465 in ² (0.30 m ²)	78 in ² (0.05 m ²)
Retroreflective or combined-performance material used in conjunction with background material	310 in ² (0.20 m ²)	201 in ² (0.13 m ²)	155 in ² (0.10 m ²)	108 in ² (0.07 m ²)	10 in ² (0.0065 m ²) Level 2
Combined-performance material used without background material	NA	NA	310 in ² (0.20 m ²)	NA	78 in ² (0.05 m ²) Level 2 or 1
Minimum width of retroreflective material	2 in (50 mm)	1.375 in (35 mm)	1 in (25 mm) or 2 in (50 mm) combined-performance material (without background material)	2 in (50 mm)	
Minimum number of yards per retroreflective material width	4.3 yds of 2 in (50 mm) width	4 yds of 1.375 in (35 mm) width 2.8 yds of 2 in (50 mm) width	4.3 yds of 1 in (25 mm) width 3.1 yds of 1.372 in (35 mm) width 2.15 yds of 2 in (50 mm) width	1.5 yds of 2 in (50 mm) wide	
Photometric performance	Level 2 (Table 4) or Level 1 (Table 5)	Level 2 (Table 4) or Level 1 (Table 5)	Level 2 (Table 4) or Level 1 (Table 5)	Level 2 (Table 4) or Level 1 (Table 5)	See Above

Note: Consult the ANSI/ISEA 107-2010 standard for Tables 4 and 5.




Photometric and Physical Performance Requirements for Retroreflective and Combined-Performance Materials

Section 8 of the standard specifies photometric and performance requirements for retroreflective and combined-performance materials, such as minimum brightness after test exposure.


- 3M retroreflective and combined-performance materials are certified to ANSI/ISEA 107-2010 specifications. (Refer to the tables in Section 7 and 8 of the standard.)
- All material must meet the minimum brightness requirements after tests for abrasion resistance, flexing, folding at cold temperatures, variation in temperatures, influence of rainfall, and laundering. When washing is indicated on the care label, the number of cycles should be tested per ISO 6330 Method 2A, 60 °C, or dry-cleaning per ISO 3759. (Refer to Section 9 of the standard.)
- Combined-performance material must also meet the minimum luminance or brightness factors after a Xenon exposure test (UV light). (Refer to Section 7 of the standard.)

XYZ Manufacturer
ANSI/ISEA 107-2010
and ANSI/ISEA 107-2004
100% Polyester
3M™ Scotchlite™ Reflective Material
Model #: Hi Vis Vest
Size: Large



Class 2
Level 2

FR- ASTM F1506-08
Washing Instructions



Wash warm Max 25 cycles
Do not bleach
Tumble dry low
Do not iron
Do not dry-clean

Care Labeling, General Marking and Instructions for Use

Once all materials have been tested against performance requirements and certificates of compliance from a third party testing laboratory have been issued, apparel manufacturers then assemble garments according to the design guidelines in Section 6 of the standard for the appropriate class of garment. Only after all the materials' performance and design requirements have been met, can a garment be labeled ANSI/ISEA 107-2010 compliant. Garment labeling, general marking and instructions for use are described in Sections 10 to 12 of the standard.

Specific Marking

- Marking includes the following information:
 - Name, trademark, or other means of identifying the manufacturer or authorized representative.
 - Designation of the product type, commercial name or code.
 - Size designation.
 - Number of this specific ANSI/ISEA standard (ANSI/ISEA 107-2010).
- Compliance with flame resistance can be indicated in one of 2 ways:
 1. The letters "FR" on the label followed by the designation of the ASTM standard specification from the list of allowed standards in Section 9.5.
 2. Garments which fully meet the third party certification requirements to NFPA 1971, 1977, or 2112, may use the separate label indicated by the NFPA standard to indicate FR compliance.
- Pictogram showing the garment Class and Level of performance for the retroreflective material.
- Care labeling with ASTM D5489-07 symbols and maximum cycles for the cleaning process.
- Instructions for Use (if applicable).

Answers To Most Frequently Asked Questions:

- 1. Are there other differences between the ANSI/ISEA 107-2004 and ANSI/ISEA 107-2010 standards?** Yes. There are additional differences between the 2004 and 2010 editions of this standard. See the companion document, “Comparison of ANSI/ISEA 107-2004 Versus ANSI/ISEA 107-2010” for additional information.
- 2. Does OSHA require the use of high-visibility safety apparel for construction workers working in highway/construction work zones at risk of being struck by traffic?** Yes. Per the OSHA Standard Interpretation, #20080829-8611, dated 8/5/2009, under OSHA Act OSH Act, 29 U.S.C. §654(a)(1), also known as the General Duty Clause, OSHA requires high-visibility apparel for flaggers, workers exposed to vehicle traffic near excavations, and for other workers in highway/construction zones which are exposed to traffic. The letter cited the regulation 23 CFR Part 634, Worker Visibility, which requires garments compliant to ANSI 107 Class 2 or 3.
- 3. Does this edition of the standard replace the 2004 edition?** ANSI 107-2010 replaces the ANSI 107-2004 version. Garment designs should be written to comply with the new version of the standard.
- 4. What version of ANSI 107 does MUTCD 2009 require?** For all workers, including emergency responders, within the right-of-way who are exposed either to traffic or to work vehicles and construction equipment within a Temporary Traffic Control zone, MUTCD 2009 Section 6D.03 requires Class 2 or Class 3 garments of ANSI 107-2004 or equivalent revisions, such as ANSI 107-2010. Section 6E.02 requires ANSI 107-2004 Class 2 or 3 for flaggers- FL orange-red or yellow green are required background colors. Section 7D.04 requires ANSI 107-2004 Class 2 for Adult Crossing Guards¹.
- 5. What are the new label requirements for ANSI 107-2010, in light of MUTCD 2009?** The MUTCD 2009 specifies that the 2004 version or equivalent revisions, e.g., the 2010 version, may be used for compliance to MUTCD, but must be labeled as ANSI 107-2004. Until an official statement is issued from MUTCD, garments meeting both requirements should be labeled as both ANSI 107-2010 and ANSI 107-2004¹.
- 6. Can NFPA 701 be used to claim flame resistance for an ANSI 107-2010 garment?** No.
- 7. Are sleeveless vests with the two horizontal stripes compliant to ANSI 107-2010?** No. The 2010 standard requires 23.5 in² of material in the shoulder area for all sleeveless garments. However, garments with sleeves which incorporate bands on the sleeves are not required to have material in the shoulder area.
- 8. Does the standard only permit the designs that are provided in the Appendix of the standard?** No. The designs provided in the appendix of the standard are only examples. There may be many innovative designs including use of primary apparel such as shirts that meet the standard and are different from the limited examples in the Appendix. Section 6 of the standard states the design requirements of the standard.
- 9. Does open weave or mesh meet the background materials requirements of the standard?** ANSI/ISEA 107-2010 is a performance standard and the material specifications are not written to include or exclude any materials if they meet the requirements for visibility or durability. Many compliant mesh products are available in the marketplace.
- 10. I have only found larger-sized garments that meet the standard. I have smaller workers that need appropriately fitting garments to work safe. Is this being addressed?** The following quote was taken from the standard, Section 6.3 Ergonomics (Page 6). “The garment shall offer the wearer the best possible degree of comfort that is consonant with provision of adequate protection. The garment shall be designed for correct fit and positioning on the user and should be designed to ensure that it remains in place for the expected period of use, anticipating environmental factor as well as movements the wearer could adopt during the course of work.” Health & Safety Managers may wish to consider the selection of a different garment style, such as a vest or shirt with sleeves, to accommodate small-framed personnel. Access our website at Scotchlite.com to learn more about the ANSI/ISEA 107-2010 standard.

11. Is this standard the same as the European EN 471 standard? No. The developers of the standard used many of the requirements of EN 471 because the science supported the performance criteria that are established. See the 3M website Scotchlite.com for an explanation of the differences.

12. Does the ANSI 107-2010 standard allow for split trim designs on a Class 2 or Class 3 garment? The split trim configuration, i.e. two 1" bands of reflective material separated by 2" of background material, is allowed by Section 6.1.1.1 of the standard. See Appendix C, Figure C-4 for an example.

Six Steps For Selecting High-Visibility Safety Apparel

Step 1: Obtain and review copies of ANSI/ISEA 107-2010 standard and relevant regulations.

Step 2: Conduct a survey of worksite low visibility hazards to determine the appropriate class of garments, as directed by the 2009 MUTCD Section 6D.03 paragraph 03 subparagraph E. Remember that the survey should account for more than speed. Also consider worker proximity to traffic, other prevailing colors, weather conditions, task loads and the traffic control plan.

Step 3: Working with the 3M team and your safety and design specialists, design concept garments that meet your needs. Remember to take a comprehensive approach to garment design in order to balance your requirements for garment functionality, comfort and durability. An ISEA study of construction work zones found that non-use of garments is related to lack of comfort and style. These issues can be addressed effectively through appropriate designs.

Step 4: Review your design choice with a visibility demonstration and/or wear test.

Step 5: Write a specification based on specific performance criteria. Require use of certified components only.

Step 6: When the safety apparel is issued to your workers, provide them with training that explains the purpose and use of their new high-visibility garments.

Look to 3M

When it comes to safety apparel, 3M is an industry leader in providing information, research, reflective applications advice, and garment design consultation. You and your workers can look to 3M for quality, reliability, and product support. Our sales and technical support staffs want to help you with selection of components and garment design, planning and executing a visibility demonstration, and developing a garment specification. For more information on how 3M can help you with your high-visibility safety apparel needs, call 800-328-7098, Ext. 2.

ANSI/ISEA 207-2006: American National Standard for High-Visibility Public Safety Vests

What is the New ANSI 207 Standard?

This public safety vest standard was created in response to public safety user group demand in 2005 for a high-visibility safety vest garment differentiated from ANSI/ISEA 107-2004 compliant apparel. The primary concern was a need for flexibility of designs that would provide tactical capability not achievable with ANSI 107 garments. Additionally, user groups expressed a desire to have a high-visibility garment standard intended for law enforcement and emergency responders that would be distinct from ANSI 107, therefore avoiding interchangeability with “construction vests”.

After receiving guidance from the National Traffic Incident Management Coalition, the ANSI Reflective Products Committee began drafting the new standard in November 2005. The standard was approved by technical committee and the ISEA (International Safety Equipment Association) in November 2006. The new standard, ANSI/ISEA 207-2006 American National Standard for High-Visibility Public Safety Vests, was published in December 2006.

Significant Differences with the ANSI 107 standard

The primary distinction of the ANSI 207 standard is that the required fluorescent background material (450 in.²) falls between ANSI 107 Class 1 (217 in.²) and ANSI 107 Class 2 (775 in.²). See chart on reverse page. This difference allows for design accommodation of equipment belts. The new standard also allows for increased design flexibility to incorporate colored panels to enhance easy, on-scene identification of wearers, as well as other options such as shoulder breakaways.

Please note: In ANSI 207, the minimum area of required retroreflective material is 201 in.², the same as the ANSI 107 requirement.

ANSI/ISEA 207-2006 Summary Points

- ANSI 207 is a new standard with a specific name, “Public Safety Vests” (PSV).
- Area requirements for fluorescent background material fall between ANSI 107 Class 1 and Class 2.
- A lesser background area requirement allows for short designs giving tactical access to equipment belts.
- Retroreflective area requirements are the same as those for ANSI 107 Class 2.

ANSI/ISEA 207-2006 Summary Points *(continued)*

- Retroreflective performance requirements are almost the same as ANSI 107, except only Level 2 (330 R_A table) is included.
- ANSI 207 is not intended to replace, or be interchangeable with ANSI 107 Class 2 apparel. Law enforcement officers performing traffic control duties are still encouraged to follow ANSI 107 Class 2 or Class 3 guidelines whenever possible.
- The new standard suggests use of many design options, such as breakaways, colored identifiers, loops, pockets, badge holders, and ID panels.
- The design options are intended to encourage innovative ways to meet end-user needs for design functionality, while still offering an effective high-visibility safety garment.

ANSI/ISEA 107-2004 Garment Class Requirements Compared to the ANSI/ISEA 207-2006 Public Safety Vest					
Minimum area of visible material					
Requirement	Performance Class 3	Performance Class 2	Public Safety Vest	Performance Class 1	Performance Class E
Background material	1240 in. ² (0.80 m ²)	775 in. ² (0.50 m ²)	450 in. ² (0.29 m ²)	217 in. ² (0.14 m ²)	465 in. ² (0.30 m ²)
Retroreflective or combined-performance material used in conjunction with background material	310 in. ² (0.20 m ²)	201 in. ² (0.13 m ²)	201 in. ² (0.13 m ²)	155 in. ² (0.10 m ²)	108 in. ² (0.07 m ²)
Combined-performance material used without background material	NA	NA	NA	310 in. ² (0.20 m ²)	NA
Minimum width of retroreflective material	2 in. (50 mm)	1.375 in. (35 mm)	2 in.	1 in. (25 mm) or 2 in. (50 mm) (combined-performance material, without background material)	2 in. (50 mm)
Minimum number of yards per retroreflective material width	4.3 yds. of 2 in. (50 mm) width	4 yds. of 1.375 in. (35 mm) width, or 2.8 yds. of 2 in. (50 mm) width	2.8 yds. of 2 in. (50 mm) width	4.3 yds. of 1 in. (25 mm) width, or 2.15 yds. of 2 in. (50 mm) width	1.5 yds. of 2 in. (50 mm) width
Photometric performance	Level 2 (Table 5) or Level 1 (Table 6)	Level 2 (Table 5) or Level 1 (Table 6)	Level 2 (Table 5)	Level 2 (Table 5) or Level 1 (Table 6)	Level 2 (Table 5) or Level 1 (Table 6)

An Overview of CAN/CSA Z96-09 High-visibility safety apparel standard

Introduction

The Canadian Standards Association (CSA) exists to produce standards that help to protect Canadians from hazards in almost every aspect of daily living. Recently, standards for personal protective equipment was developed by CSA with the support of many Canadian employer/labour users, producers, special interest groups, and regulators. The CAN/CSA Z96-09 addresses high visibility safety apparel, an area where consistency in Canadian regulations and standards was necessary.

CAN/CSA Z96-09: Elements

Classification of High Visibility Garments

- Three classes of garments

Garment Design Criteria

- Trim placement to enhance visibility and safety
- Apparel design considerations for emergency first responders

Background material – Daytime Visibility

- Performance tests and colour specifications

Retroreflective material – Nighttime Visibility

- Performance specifications

FR issues

- Special design and performance allowances for garments intended for FR applications

Certification and Labels

- Self-Declaration
- Detailed Garment Labels

Classification of Garments

	Class 1 Apparel	Class 2 Apparel	Class 3 Apparel
Description of Minimal Coverage	Basic harness or stripes/ bands over the shoulder(s) and encircling the waist.	Full coverage of upper torso (front, back, sides and over the shoulders*). Minimum side coverage of 50% from bottom edge of garment to shoulder point.	Class 2 apparel plus bands encircling both arms and both legs. These bands shall be composed of combined performance stripes/bands or a combination of retroreflective and background material.
Background material minimums	0.14 m ² (minimum) (217 in ²)	See Above	See Above
Retroreflective or combined performance material used in conjunction with background material	0.10 m ² (155 in ²)	0.13 m ² (202 in ²)	0.20 m ² (310 in ²)
Photometric performance	Level 1 or Level 2	Level 1 or Level 2	Level 2
Combined-performance material used without background material	0.20 m ² (310 in ²)		
Photometric performance	Level 1 or Level 2		

* As a special case, bib style overalls are recognized as Class 2. Bib-style overalls are not required to have retroreflective material over the shoulders, but may include retroreflective or combined-performance material around the legs.

CAN/CSA Z96-09 Garment Classes

Class 1 Apparel



Basic harness or stripes/bands over the shoulder(s) and encircling the waist.

Class 2 Apparel



Full coverage of upper torso (front, back, sides and over the shoulders). Minimum side coverage of 50% from bottom edge of garment to shoulder point.

Note: The center portion of the front torso band, between the two vertical bands, is optional.

Class 2 Apparel (Special Case)



As a special case, bib-style overalls are recognized as Class 2 apparel. Retroreflective material over the shoulder is optional.

Note: The leg bands shown here are optional.

CAN/CSA Z96-09 Garment Classes (cont.)

Class 3 Apparel



Class 3 apparel is Class 2 apparel plus arm and leg bands. These bands shall be composed of combined performance stripes/bands or a combination of retroreflective and background material.

Class 3 Apparel (Minimum)



Class 3 apparel is Class 2 apparel plus arm and leg bands. These bands shall be composed of combined performance stripes/bands or a combination of retroreflective and background material.

CAN/CSA Z96-09 Alternative Garment Designs

Class 2



Class 3



Stripes/Bands Configuration



Note: The center portion of the front torso band, between the two vertical bands, is optional.

Stripes/bands shall be laid in the following distinctive standardized pattern:

- A symmetric "X" on the back extending from the shoulders to the waist
- Two vertical stripes on the front extending over the shoulders and down to the waist
- A waist-level horizontal stripe extending entirely around the back to the bottom of the vertical stripes

Stripes/Bands Requirements



- All bands shall be not less than 50 mm in width
- Gaps for fastening or seams shall not exceed 50 mm
- Multiple bands must be spaced a minimum of 50 mm apart
- Bands near edges shall not be placed less than 50 mm from edge
- Horizontal stripes/bands placed on sleeves or pant legs shall encircle the arms or legs
- Horizontal stripes/bands on the legs shall be placed at or below the knee

Patches and Lettering

Retroreflective



- 500 cm² (15 cm x 33 cm)
- 77 ½ in² (7" x 11")
- Can not obscure pattern

Non - Retroreflective



- 100 cm² (5 cm x 20 cm)
- 15 ½ in² (2" x 7-3/4")
- Can not cover trim

Chromaticity and Luminance

Fluorescent Materials shall comply with one of the 3 colours in Table 2A. Bright coloured background materials shall comply with one of two colours specified in Table 2B.

Allowance for determination of colour and luminosity of mesh type background materials in a 2 ply form (harmonized with ANSI/ISEA 107)

Table 2A – Colour, Fluorescent background material

Colour	Chromaticity coordinates		Minimal luminance factor
	x	y	8 min
Fluorescent Yellow-Green	0.387 0.356 0.398 0.460	0.610 0.494 0.452 0.540	0.76
Fluorescent Orange-Red	0.610 0.544 0.579 0.655	0.390 0.376 0.341 0.344	0.40
Fluorescent Red	0.655 0.579 0.606 0.690	0.344 0.341 0.314 0.310	0.25

Table 2B – Colour, Bright background material

Colour	Chromaticity coordinates		Minimal luminance factor
	x	y	8 min
Bright Yellow-Green	0.387 0.356 0.398 0.460	0.610 0.494 0.452 0.540	0.38
Bright Orange-Red	0.610 0.517 0.570 0.655	0.390 0.370 0.340 0.344	0.17

Flame Resistant Allowances

The stripes or bands shall be not less than 50 mm wide and shall have retroreflective or both retroreflective and fluorescent surfaces

Flame Resistant Garments - Examples

Class 1/Level FR

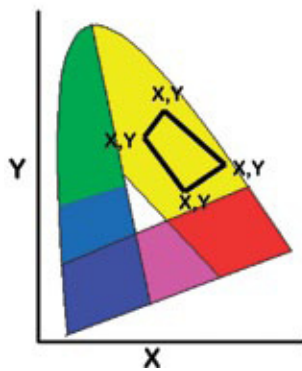


7.2.2.3 The design of the stripes or bands on the garment should also comply with Clause 4.2.2

Class 3/Level 2



Background Material - Daytime Visibility



Bright or
Fluorescent
Orange-Red

Bright or
Fluorescent
Yellow-Green

Fluorescent Red

Retroreflective Material - Nighttime Visibility

Level 2

Table 5: Minimum coefficient of retroreflection in cd/ (lx m²) for Level 2 retroreflective or combined-performance retroreflective material

Observation angle	Entrance angle			
	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

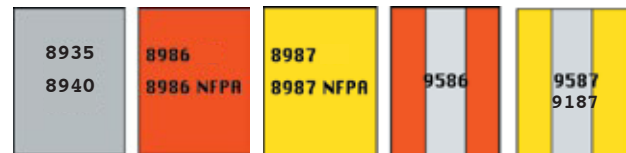


These 3M™ Scotchlite™ Reflective Material products meet and exceed Level 2 brightness

Level FR

Table 7: Minimum coefficient of retroreflection in cd/ (lx m²) for Level FR retroreflective or combined-performance retroreflective material

Observation angle	Entrance angle			
	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



These 3M™ Scotchlite™ Reflective Material products meet and exceed Level FR brightness

Label Requirements

Safetywear Co. Utility Coverall – Model 1000

3[™] Scotchlite[™] Reflective Material –
8940 Silver Industrial Wash FR Fabric

Size: Extra Large

CAN/CSA Z96

Class 3

Level 2

FR Bright Orange-Red

NOMEX[®] Background Material



Machine wash warm, 60°C (140°F)
Only non-chlorine bleach, if needed
Tumble dry low
Iron medium
Dry-clean normal



- Indication of background material as “fluorescent” or bright-coloured
- Indication of FR performance, if applicable

Selection, Care and Use



- Evaluate the workplace background or the environment
- Consider the work conditions (e.g. indoor or outdoor?)
- Calculate the degree of exposure to hazards
- Speeds of vehicles (warning distances and times)
- Existing engineering and administrative hazard controls
- Compatibility with other P.P.E used
- Sight lines of vehicle operators
- Special occupational needs
- Is the retroreflective product certified to CAN/CSA Z96-09?

The Canadian Standards Association has developed CSA Z96.1, a guideline on the Selection, Care and Use of High-Visibility Safety Apparel. This guide specifies best practices necessary for the implementation of an effective HVSA program in the workplace.

CAN/CSA Z96-09: Summary

Minimum trim width:

- 50 mm

Stripes/ bands pattern:

- Symmetric “X” on the back
- Two vertical stripes on the front
- Waist-level horizontal stripe extending entirely around garment

Others:

- Gaps for fastening or seams shall not exceed 50 mm
- Bands be placed no closer than 50 mm from edges
- ID Patches and Lettering
 - Retroreflective = 500 cm²
 - Non-Retroreflective = 100 cm²

- Examples of manufacturer’s compliance declaration forms.

- Full body coverage provides better conspicuity than partial body coverage

- Coverage of 360° around the body provides better conspicuity in all viewing directions

- Contaminated or dirty retroreflective materials provide lower conspicuity

- For optimal performance, garments should be maintained in accordance with the manufacturer’s instructions

- CAN/CSA Z96.1-08, Guideline on selection, care and use of high visibility safety apparel



CAN/CSA Z96-09 Classes	Class 1	Class 2	Class 3
Trim Levels (Minimum Ra)	Level FR (>65 Ra)	Level 1 (>250 Ra)	Level 2 (>330 Ra)
Background Colours (Fluorescent or Bright)	Yellow-Green	Orange-Red	Red



A Quick Reference to Insulating Apparel Used in Cold Work Environments

Overview

ANSI/ISEA 201-2012, the American National Standard for Classification of Insulating Apparel Used in Cold Work Environments, is a new consensus standard established by the American National Standards Institute, Inc., directed to utility, construction, maintenance, airport, and other workers who are routinely exposed to the hazards of cold temperatures while on the job. With this standard, for the first time, insulating cold weather clothing can be measured, certified, and specified as PPE according to user-required performance and without design restrictions. This standard provides guidelines for the testing, specification, selection, and use of insulating apparel such as parkas, vests, coveralls, pants, and insulated flame resistant workwear. Gloves, headwear, and footwear are not included, although any specifier must include these items in the ensemble to achieve functional protection.

This information, ANSI/ISEA 201-2012 Made Easy: A Quick Reference to Insulating Apparel Used in Cold Work Environments, summarizes the main provisions of the standard including performance criteria, durability requirements, and certification procedures. You can obtain a copy of the standard from the ISEA website, SafetyEquipment.org, and refer to it for more detailed information. Garment designs should incorporate the full range of needed attributes for functionality, comfort, durability and image.

ANSI/ISEA 201-2012 specifies the following:

- A consistent and specific method of rating insulative garments for intrinsic insulation value (clo units)
- Six insulative performance categories and a temperature rating system
- Four durability classes based on retention of insulation properties as a function of the number of manufacturer-specified cleaning cycles
- Certification Requirements
- Care Labeling and Specific Marking

Definitions (§4.)

Accredited laboratory: A laboratory having a certificate of accreditation meeting the requirements of ISO/IEC Guide 17025:2005 (or other equivalent standard) for the collection and analysis of data within the parameters of this standard.

Certify: To provide documentation from either an independent, third-party laboratory or to self-certify through the use of the Apparel Compliance Certificate (See Appendix C)

clo: Unit of thermal resistance defined as the insulation required to keep a resting man (producing heat at the rate of 58 W/m²) comfortable in an environment at 21°C, air movement 0.1 m/s. Numerically, one clo is equal to 0.155 K m²/W (or roughly the

insulation value of a heavy business suit). The following insulation values can be determined with a thermal manikin using clo units:

- I_a thermal resistance (insulation) of the air layer on the surface of the nude manikin.
- I_t total thermal resistance (insulation) of the clothing and surface air layer around the manikin.
- I_{cl} intrinsic thermal resistance (insulation) of the clothing.

Clothing ensemble: A group of apparel items worn together on the body at the same time.

Durability class: Garment designation related to the loss of insulating properties as a function of the number of repeated standardized laundry cycles.

Home laundering: Washing/finishing of textiles according to size and volume needed by a single household, and typically at milder temperatures and with less aggressive wash chemistries than industrial laundering.

Industrial laundering: Professional laundering of workwear in greater quantities, and typically at higher temperatures and with more aggressive wash chemistries than home laundering

MET, or MET value: Unit of metabolic rate defined as the amount of heat produced by a man seated at rest. 1 MET = 58 W/m² (watts per square meter).

Performance category: Garment designation related to the garment's intrinsic insulating clo value.

Self-certify: To verify apparel design requirements within this standard without the use of an independent accredited laboratory or other third-party.

Temperature rating: The coldest environmental temperature at which a person can remain thermally neutral while wearing a particular clothing ensemble (neither gaining nor losing heat to the environment) at a specified activity level or metabolic rate.

Thermal insulation: The resistance to dry heat transfer by way of conduction, convection, and radiation.

Specific Descriptions

Insulation Clo: clo is the measured value of the thermal effectiveness of clothing insulation. The practices and test methods referenced in this standard assign and hold constant certain assumptions about the undergarments or accompanying clothing ensemble, activity level, and exposure environment in order to generate a reliable clo measurement. By using a defined standardized measurement methodology, it is possible to assign garment insulation performance categories based on clo that are performance comparable from garment to garment yet with little restriction on garment design.

Wash cycles: Uniforms or workwear are expected to be worn on the job with regular frequency. Maintaining a minimum required performance of that clothing over a reasonable expected lifetime is critical to the protection of the worker and the optimization of cost of ownership of the garment. Cleaning cycles, whether performed at home or as part of a commercial laundry program, are proxies for the wear forces a garment will experience over its useful life. Insulative garments which cannot maintain performance over minimum repetitions of cleaning are probably not suitable for occupational use.

Compliance and Certification (§3.)

Garments shall be tested for intrinsic insulation value (clo) after laundering, according to forms B1 & B2. The garment manufacturer seeking certification typically chooses the laundry method according to the intended application of the garment. The clo value after the designated wash regimen is used to assign the insulation class and durability category. This information is recorded on the Apparel Compliance Certificate Form B3. While it is possible that a manufacturer could conduct all required testing in-house and self-certify its garments, it is more likely that an established test laboratory with the appropriate specialized equipment and technical capability will be used to measure the clo values and provide the performance certification.

Care Labeling, General Marking and Instructions for Use, Specific Marking (§9-11.)

Each garment shall include a label. Care labeling shall be indicated in accordance with ASTM D 5489 07. The garment care that the manufacturer recommends on the label may be different from the standardized wash cycle that is used for performance certification. To be ANSI/ISEA 201-2012 compliant, the garment label will also include the standard number, identification of the manufacturer, a specific product model or type designation, size, the post-laundering intrinsic insulation (clo) value reported as a range or the actual value, the Thermal Performance Category, the temperature rating, and the durability class(es) with laundry procedure(s) identified. Garment labeling, general marking, and instructions for use are described in Sections 9, 10 and 11 of the standard.

References

ASTM D 5489-07 Standard Guide for Care Symbols for Care Instructions on Textile Products

ASTM F 1291-10 Standard Test Method for Measuring Insulation Value of Clothing using a Heated Manikin

ASTM F2732-11 Standard Practice for Determining the Temperature Ratings for Cold Weather Protective Clothing

Tables

Table 2 from §8: ANSI/ISEA 201-2012 Thermal Insulation Performance Categories

Table 2: Performance Categories	
Category	Intrinsic Insulation Value (clo)
6	≥3.50
5	3.00 – 3.49
4	2.50 – 2.99
3	2.00 – 2.49
2	1.50 – 1.99
1	.75 – 1.49

Temperature ratings are established assuming an activity level, or metabolic rate, of 2 MET (116 W/m²). It is also allowed to provide an additional temperature rating at an activity level of 4 MET (233 W/m²).

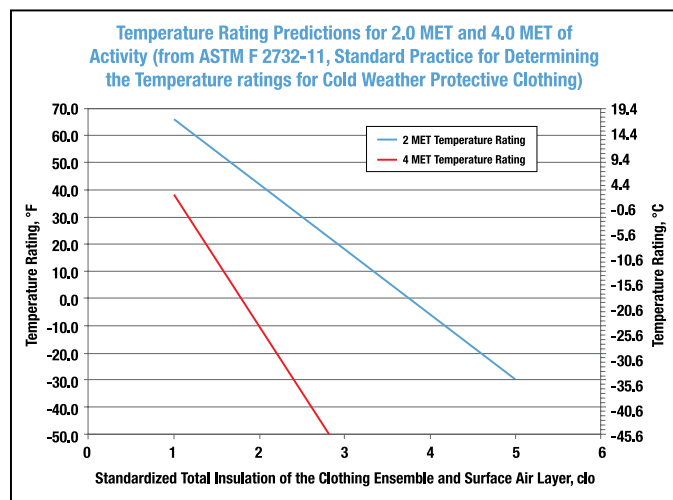


Table 1 from §7: ANSI/ISEA 201-2012 Wash Durability Classes

Table 1: Durability Classes (Number of Launderings)				
Laundering Method	Durability Class			
	Class 1	Class 2	Class 3	Class 4
Dry Clean				
ISO 3175-2:1998	5X	10X	25X	50X
Home Laundering ISO 6330:2000				
Level 1 Procedure 2A	5X	10X	25X	50X
Level 2 Procedure 4A	5X	10X	25X	50X
Level 3 Procedure 5A	5X	10X	25X	50X
Level 4 Procedure 7A	5X	10X	25X	50X
Level 5 Procedure 8A	5X	10X	25X	50X
Level 6 Procedure 4B	5X	10X	25X	50X
Level 7 Procedure 6B	5X	10X	25X	50X
Level 8 Procedure 9B	5X	10X	25X	50X
Industrial Wash ISO 5797:2002				
Use the procedure for Colored Workwear				
Level 1 White Cotton (85°C)	5X	10X	25X	50X
Level 2 Polyester/Cotton (75°)	5X	10X	25X	50X

Six Steps For Selecting/Designing Insulating Apparel Used in Cold Work Environments

(see also Appendix A of the standard)

Step 1: Obtain and review copies of ANSI/ISEA 201-2012 standard and relevant regulations.

Step 2: Conduct a survey of worksite low temperature conditions to determine the appropriate category of garments.

Step 3: Working with the 3M team and your safety and design specialists, select or design concept garments that meet your needs. Remember to take a comprehensive approach to garment design in order to balance your requirements for garment functionality, comfort and durability. An ISEA study of construction work zones found that non-use of garments is related to lack of comfort and style. These issues can be addressed through appropriate designs.

Step 4: Review your design choice with a field trial.

Step 5: Write a specification based on specific performance criteria. Require use of certified components only.

Step 6: When the safety apparel is issued to your workers, provide them with training that explains the purpose and use of their new garments.

Examples of Occupational and Consumer Garments

Label example from the standard: This corresponds to an Insulated Coverall that has been designed to be either Home Washed at least 25 times per ISO 6330-2000 following Procedure 4A (Front loading home washer at a hot temperature (50°C) and normal agitation). At such conditions, it exhibited a clo value between 2.0 clo and 2.49 clo (earning a Category 3 classification). The light work activity Temperature rating corresponding to this was 33°C, while the heavy work activity Temperature rating was -30°C. This garment also exhibited these clo values and temperature ratings when Industrial Laundered five times according to ISO 15797-2002 at 75°C.

Manufacturer Name
Insulated Coverall #xxx XL-tall
ANSI/ISEA 201-2012
Thermal Performance Category 3 Insulation range 2.0 – 2.49 clo
Temperature Rating 33° F for light work activity (2 MET) to Temperature Rating -30° F for heavy work (4 MET)
As defined by ASTM F 2732-11
Home Wash Durability Class 3 max 25 x, ISO 6330-2000 Procedure 4A
Industrial Wash Durability Class 1 max 5 x, ISO 15797-2002 75° C
Available space for manufacturer care instructions, apparel composition, etc.



Answers To Your Most Frequently Asked Questions

1. Are there any other Global Standards similar to this?

No, there are no other standards that address the same performance aspects of cold weather garments as contained in the ANSI/ISEA 201-2012 standard.

2. Can I Self-Certify?

The equipment that is required for measuring clo values per the referenced standards is highly specialized, expensive, and requires a technical competence beyond that which is generally available in most companies. More likely, a third party test facility that has already invested in the appropriate equipment and laboratory capabilities will be needed.

3. What third party test facilities will be able to provide the needed assessments and certifications?

While there may be a number of locations that could offer such services, one such facility that has already indicated their willingness and ability to conduct this testing is:

Institute for Environmental Research.
Dr. Elizabeth McCullough, Co-Director
Kansas State Univ. - 64 Seaton Hall
Manhattan, KS 66506
785-532-2284

4. Is the “clo value” determined during this testing only that of the specified article?

The “clo value” determined during the testing also includes a base layer of apparel as specified in the ASTM standard. This base layer is the same for all garments certified to ANSI/ISEA 201-2012.

5. Is the “clo value” measured on garments before they are subjected to laundering?

No, for the purpose of certification to ANSI/ISEA 201-2012, the clo value is determined only after garments have been laundered the indicated number of cycles.

6. What about layering of clothing? Do the clo numbers all add up?

Adding two “1.5 clo” clothing layers does not necessarily provide you with a “3 clo” ensemble, because the trapped air that provides insulation in the layers may increase or decrease depending on how the garments fit together. You can layer clothing to achieve an improvement in clo value over either layer taken individually. Two “1.5 clo” layers would provide up to 3 clo of insulation.

2009 MUTCD Revision Final Rule 16 December 2009

The Federal Register Final Rule and revised document of the 2009 Manual on Uniform Traffic Control Devices (MUTCD) was released on December 16, 2009.

This is significant to high visibility apparel users for several reasons and will affect the occupational high-visibility apparel marketplace for years to come. Please make note of the following significant changes:

- (1) The MUTCD is now the primary regulatory document mandating the use of high-visibility apparel for all affected workers in the U.S.
- (2) 23 CFR Part 634 is now vacated, with the language carried into the MUTCD Section 6D.03
- (3) Mandatory use areas are expanded beyond Federal-aid highways and will cover all roads “open to public travel,” i.e., any road where you can drive a car without passing through a traffic control gate, including private property.
- (4) Phase-in for compliance on all public roads which are not Federal aid Highways is two years, ending on 31 Dec 2011. Regulations on Federal aid Highways continue in force, since Nov 2008.
- (5) All workers, including emergency responders, within the right-of-way are required to wear high-visibility safety apparel that meets performance Class 2 or 3 of ANSI/ISEA 107-2004, or equivalent revisions. Labeling requirements may require additional clarification, however.
- (6) The use of ANSI/ISEA 207-2006 Public Safety Vest compliant garments is included as an option for emergency and incident responders and law enforcement officers to meet requirements of this regulation in lieu of ANSI/ISEA 107-2004. “When uniformed law enforcement personnel are used to direct traffic, to investigate crashes, or to handle lane closures, obstructed roadways, and disasters, high visibility safety apparel shall be worn.”
- (7) Requirements for firefighters are now subject to the option in the following paragraph:
“Firefighters or other emergency responders working within the right-of-way and engaged in emergency operations that directly expose them to flame, fire, heat, and/or hazardous materials may wear retroreflective turnout gear that is specified and regulated by other organizations, such as the National Fire Protection Association.”
It is 3M’s interpretation that NFPA 1971 turnout gear is an example of a standard that meets this requirement.

(8) Worker Safety Plan in the 2009 MUTCD:

“A trained person designated by the employer should conduct a basic hazard assessment for the worksite and job classifications required in the activity area.” “This plan should be in accordance with the Occupational Safety and Health Act of 1970, as amended, General Duty Clause Section 5(a) (1) – Public Law 91-596, 84 Stat.1590.

(9) Uniform of Adult Crossing Guards Section 7D.04:

“Law enforcement officers performing school crossing supervision and adult crossing guards shall wear high-visibility retroreflective safety apparel labeled as ANSI 107-2004 standard performance for Class 2 as described in Section 6E.02” Labeling requirements may need additional clarification, however.

Federal Register Link to View the Public Notice:

A Federal Register Link to the Final Rule of the 2009 MUTCD Revision is shown below:

<http://edocket.access.gpo.gov/2009/pdf/E9-28322.pdf>

A link to the full text of 2009 MUTCD is shown below:

<http://mutcd.fhwa.dot.gov/pdfs/2009/mutcd2009edition.pdf>

Information is current as of January 13, 2010

EN 471: in a nutshell

EN 471: 2003 High-visibility warning clothing for professional use - Test methods and requirements

Garments class

Minimum amount of highly visible material, in m², according to Table 1 of EN 471:

	Class 3	Class 2	Class 1
Background material	0,80	0,50	0,14
Retroreflective material	0,20	0,13	0,10
Combined performance material	-	-	0,20

The amount of material shall be calculated on the smallest size available, with the garment flat on the table.

Design indications

There are several requirements for design. Here the most important:

- The background material shall encircle the torso, and, where applicable, the sleeves and trouser legs.
- Bands of retroreflective material shall be not less than 50 mm wide;
- 3 possible design type for jackets, waistcoats, shirts, coats and tabards



§4.2.3.b Two horizontal, two vertical



§4.2.3.c One horizontal, two vertical



§4.2.3.d Two horizontal stripes

- The horizontal stripes can have a maximum inclination of 20%
- The distance between two bands has to be at least 50 mm
- Gaps in the horizontal stripes are admitted for seams and fastening. They shall not wider that 50 mm each and in total not greater that 100 mm for the torso and 50 mm for sleeves and trousers leg.

Requirements for background materials

Three colors are possible: fluorescent red-orange, fluorescent yellow and fluorescent red. The colors are very well defined by the luminance factor and the color box (Table 2). There are several requirements for fluorescent materials, like resistance to UV radiation (done with the xenon test), color fastness after perspiration, laundering, dry cleaning, bleaching, hot pressing and minimum tensile strength, dimensional changing, breathability ...

Requirements for retroreflective material

The retroreflective material can be of level 2 or 1, as defined in Table 5 and 6. If it is a combined performance material, than it has to fulfill much lower retroreflective requirements, as reported in Table 7. It is for this reason, that combined performance materials are allowed only for Class 1 garments (lower level of protection). Also the reflective materials have to fulfill additional requirements, like resistance to abrasion, washing, dry cleaning, industrial laundering and rainfall. After all these test, the retroreflective material, shall still have a minimum performance at the head on angle (observation angle 12°, entrance 5°). This is different for retroreflective materials, 100 cd/(lx m²), and combined performance, 30 cd/(lx m²) [and 15 cd/(lx m²) after rainfall].

Important Notice to User

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PRODUCT USE: Because of the unlimited variety of potential applications for these products, BEFORE production use, the user (which may be a product designer, product specifier, converter or end product manufacturer or others) must determine that the Products are suitable for the intended use and are compatible with other component materials. User is solely responsible for determining the proper amount and placement of Products. While reflective products enhance visibility, no reflective product can ensure visibility or safety under all possible conditions. 3M may change the product, specifications and availability of the product as improvements are made; therefore, user should contact 3M for latest information before specifying the product.



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