3M Scotchlite™
Reflective Material

ANSI/ISEA 107-2004 MADE EASY: A Quick Reference to High-Visibility Safety Apparel

The American National Standard for High-Visibility Safety Apparel and Headwear (ANSI/ISEA 107-2004) is a standard established by American National Standards Institute, Inc.

Construction, utility, police, emergency medical services, fire fighters and airport ramp 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.

Significant changes to the first edition (ANSI/ISEA 107-1999) include recognition of headwear as high visibility accessory products, inclusion of reflective patterns, such as logos, the distinction between woven and knitted fabrics as background material, and removal of previous test criteria that added no value. The appendices have been expanded to include additional examples of garment designs and now include forms for standard test reports and an apparel and headwear compliance certificate.

This information, ANSI/ISEA 107-2004 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 107-2004 standard. Garment designs should incorporate the full range of your needs for functionality, comfort, durability and image.

ANSI/ISEA 107-2004 specifies the following:

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

Scope & Purpose: It's about people

Before the first publication of this standard in 1999, there was no regulation or specific guideline for the design and performance of materials for high visibility safety apparel in the U.S. Since 1999, private industry as well as various federal, state, and local authorities have recognized the ANSI/ISEA 107-1999 standard.

Until the release of the 2003 edition, the MUTCD provided only general guidelines for worker visibility in work zones, requiring that flaggers wear garments visible from 1,000 feet away. Historically, MUTCD focused on visibility from the driver's perspective: the use of traffic cones, barrels, and signs to provide motorists with visual cues and clear channels of traffic. In the 2003 edition, the writers specify requirements for use of high visibility apparel compliant with ANSI/ISEA 107 by both flaggers and other roadway workers, and in doing so, place the focus on visibility from the worker's as well as the driver's perspective.

Definitions

Retroreflective, combined-performance, and background materials are to be certified to the 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 is a retroreflector and is either (1) not intended to comply with the requirements of the standard for background material, or (2) is a combined-performance, retroreflective material.

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

Design

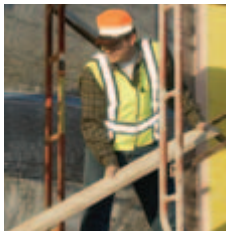
The ANSI/ISEA 107-2004 standard provides design guidelines and specifies the minimum amounts of component materials, colors, and placement to enhance the visibility of workers. Refer to Section 6 of the standard for more detailed information. The selection of components and classes of apparel should 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 have been added to the description of Class E garments, and Table 1 has been revised to include Class E garments and headwear minimum areas.



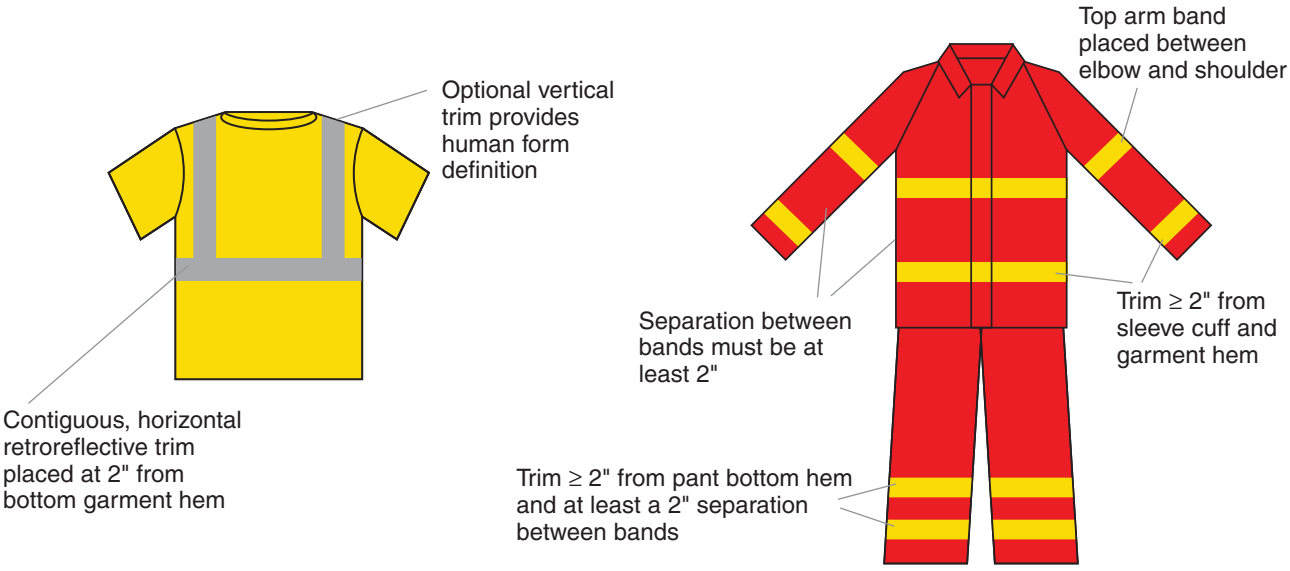
Class 1 Garments

Class 2 Garments

Class 3 Garments

Table 1. Minimum Areas of Visible Material	ANSI/ISEA 107-2004				
	Performance Class 3	Performance Class 2	Performance Class 1	Performance Class E	Headwear
Background material	1240 in² (0.80 m²)	775 in² (0.50 m²)	217 in² (0.14 m²)	465 in² (0.30 m²)	78 in² (0.05 m²)
Retroreflective or combined-performance material used in conjunction with background material	310 in² (0.20 m²)	201 in² (0.13 m²)	155 in² (0.10 m²)	108 in² (0.07 m²)	10 in² (0.0065 m²) Level 2
Combined-performance material used without background material	NA	NA	310 in² (0.20 m²)	NA	78 in² (0.05 m²) Level 2 or 1
Minimum width of retroreflective material	2 in. (50mm)	1.375 in. (35mm)	1 in. (25mm) or 2 in. (50mm) combined-performance material (without background material)	2 in. (50mm)	
Minimum number of yards per retroreflective material width	4.3 yds. of 2 in. (50mm) width	4 yds. of 1.375 in. (35mm) width 2.8 yds. of 2 in. (50mm) width	4.3 yds. of 1 in. (25mm) width 3.1 yds. of 1.372 in. (35mm) width 2.15 yds. of 2 in. (50mm) width	1.5 yds of 2 in. (50mm) wide	
Photometric performance	Level 2 (Table 5) or Level 1 (Table 6)	Level 2 (Table 5) or Level 1 (Table 6)	Level 2 (Table 5) or Level 1 (Table 6)	Level 2 (Table 5) or Level 1 (Table 6)	Level 2 (Table 5) or Level 1 (Table 6)

Note: Consult the ANSI/ISEA 107-2004 Standard for Tables 5 and 6.



Retroreflective Material Placement

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

- Use of retroreflective band widths appropriate for the garment class. (Refer to Table 1.)
- 360° visibility with at least one retroreflective band encircling the torso.
- Appropriate separation distances of vertical and horizontal bands placed on the torso, sleeves and trouser areas.
- Appropriate horizontal gaps in 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.

Ergonomics

- Apparel should offer the wearer the best possible degree of comfort consistent with the provision of adequate protection.
- Garment designs should be free of roughness and sharp edges that could cause excessive irritation.
- Adequate size ranges should be offered so the apparel offered is adapted to the shape of the user.

Requirements for Retroreflective and Combined-Performance Materials

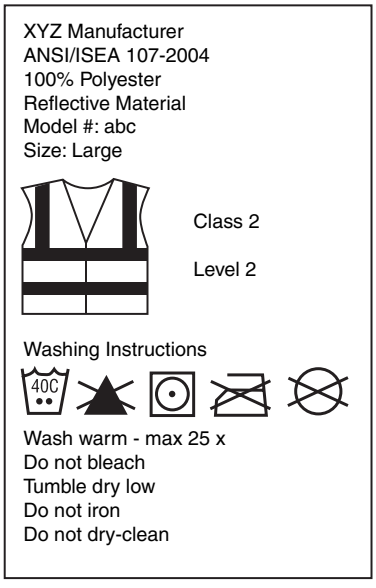
Section 7 of the standard provides specifications for color, brightness, fabric strength and moisture resistance after various exposure tests.

- Background material needs to be tested for chromaticity or color, and luminance or brightness.
- It must also be tested for color fastness with four tests: crocking, perspiration, laundering and Xenon (UV light) exposure.
- Background materials need to be tested for dimensional change (shrinking) after washing and dry-cleaning.
- Other tests include tensile strength, tear resistance, bursting strength of woven material and bursting strength of knitted material. Background materials also need to be tested for water penetration and water repellency, if the garment is intended to provide protection during rainfall.

Photometric and Physical Performance Requirements for Retroreflective Material

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

- 3M retroreflective and combined-performance materials are certified to ANSI/ISEA 107-2004 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 and variation in temperatures.
- 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.)



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 107-2004 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 107-2004).
- Pictogram showing the garment Class and Level of performance for the retroreflective material.
- Care labeling with FTC symbols and maximum cycles for the cleaning process.
- Instructions for use (if applicable).

Answers To Your Most Frequently Asked Questions

1. **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 is established. See the 3M website www.3M.com/Scotchlite for an explanation of the differences.

2. **Does this edition of the standard replace the 1999 edition?** Yes. To quote ISEA's technical director, "The 2004 edition replaces the 1999 version, period." (Janice Bradley, October 2004 e-mail) Garment specifications should be written around ANSI/ISEA 107-2004.

3. **Is there a difference between the ANSI/ISEA 107-1999 and ANSI/ISEA 107-2004 standard?** There are differences between the 1999 and 2004 editions of this standard. See the companion document, "Comparison of ANSI/ISEA 107-1999 Versus ANSI/ISEA 107-2004" for additional information.

4. **Does OSHA know about this?** Yes. What is their position? As with many of the other Personal Protective Equipment (PPE) standards that ISEA develops, ANSI/ISEA 107-2004 is being publicized and distributed to all areas of the federal, state and local governments for recognition as a guide for high-visibility apparel and the workers who use them. OSHA encourages the development of voluntary industry consensus standards and is an advocate for their use. Two states, Minnesota (MN OSHA 5205) and Washington (WAC 296-155) have adopted the standard into law.

5. **Does a sleeveless vest qualify as a Class 3 garment?** No. The writers of the standard never intended that a Class 3 garment design be considered a vest, but rather a garment that provides the highest level of visibility (such as a vest with Class E pants, jackets, coveralls or rain suits) at a minimum of 1,280 feet and through a broad range of body motions. "Regardless of the area of materials used, a sleeveless garment or vest alone shall not be considered Performance Class 3." (Page 2, Section 5.2.1 ANSI/ISEA 107-2004)

6. **Which is more effective *during the day*: garments with combined-performance material or retroreflective (silver) trim?** Human factors studies show that both fluorescent orange and fluorescent yellow-green fabrics perform better than non-fluorescent background colors in daytime conditions. You should use a visibility demonstration as the tool to determine component color preferences for the entire garment.

7. **Which is more effective in *nighttime* conditions, garments with combined-performance material or retroreflective material?** According to a 1999 human factors study,[1] silver products which reflect white are equally conspicuous to the human eye at various distances when compared with colored reflective products such as orange, red or green. The quantity of retroreflective trim, brightness and placement are the important factors to achieve enhanced visibility. According to the UMTRI 2000-35 study[2], in low-light and nighttime conditions color contrast was not an identifiable attribute, as all retroreflective materials used appeared white when illuminated. Again, a visibility demonstration is the best tool to determine effectiveness of retroreflective materials in low-light conditions and at night.

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 107-2004 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. **My workers are only out during the day. Why do I need so much retroreflective materials that affect the cost of the garments?** Great variability in illumination conditions exists in daytime or nighttime due to weather, daylight savings time, and many unexpected work delays or emergencies that may require employees to work beyond normal shift hours. A national standard should protect workers in all possible lighting conditions, day or night.

11. **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?** Quoting from the standard, Section 6.3 Ergonomics (Page 5-6): "The high-visibility safety apparel shall offer the wearer the best possible degree of comfort that is consistent with provision of adequate protection. . . . High visibility safety apparel shall be fitted to correct positioning on the user and should ensure that it remains in place for the expected period of use." Health & Safety Managers may wish to consider the selection of a different garment style to accommodate small-framed personnel.

Access our website at www.3M.com/Scotchlite to learn more about the ANSI/ISEA 107-2004 standard.

Six Steps For Selecting High-Visibility Safety Apparel

Step 1: Obtain and review copies of ANSI/ISEA 107-2004 standard and relevant regulations.

Step 2: Conduct a survey of worksite low visibility hazards to determine the appropriate class of garments. Remember that the survey should account for more than speed. Also consider weather conditions, worker proximity to traffic, 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.[3] These issues can be addressed through appropriate designs.

Step 4: Review your design choice with a visibility demonstration.

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.

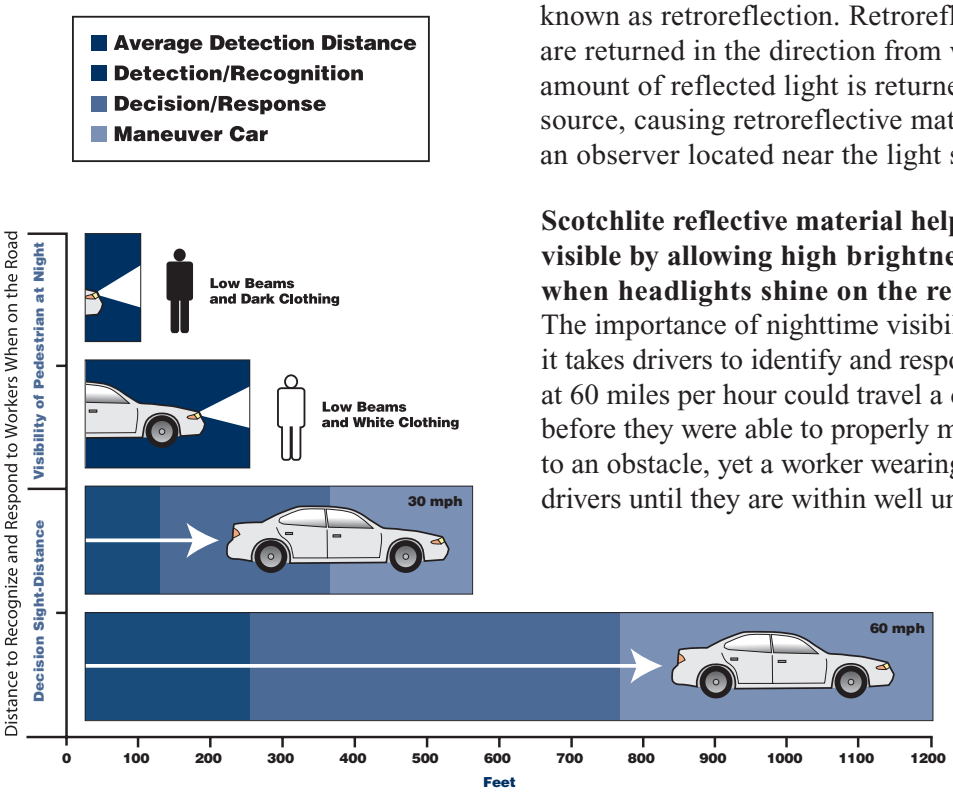
[1] *The Nighttime Conspicuity of Pedestrians in Urban Environments*, Gunnar D. Jenssen, Terje Moen and Bjorn Brekke; SINTEF Civil and Environment Engineering, Transportation and Energy Research; N-7465 Trondheim, Norway: presented at Vision in Vehicles 8, August 22-25, 1999, Boston, MA.

[2] University of Michigan Transportation Research Institute (UMTRI 2000-35) "The Effect of Color Contrast On Daytime and Nighttime Conspicuity of Roadworkers Vests."

[3] International Safety Equipment Association (ISEA) Protection Update Newsletter, Summer 2002

[4] R.D. Blomberg, A. Hale, and D.F. Preusser, "Experimental Evaluation of Alternative Conspicuity-Enhancement Techniques for Pedestrians and Bicyclists," Journal of Safety Research, Volume 17, pp. 1-12, 1986. "Decision Sight Distance for Highway Design and Traffic Control Requirements," Report number FHWA-RD-78-78.

How reflective material works.



3M™ Scotchlite™ Reflective Material products use a technology known as retroreflection. Retroreflection occurs when light rays are returned in the direction from which they came. A large amount of reflected light is returned directly to the original light source, causing retroreflective materials to appear brightest to an observer located near the light source.

Scotchlite reflective material helps keep your employees more visible by allowing high brightness in low-light situations when headlights shine on the reflective material.
The importance of nighttime visibility is evident in the time it takes drivers to identify and respond to a worker. Drivers moving at 60 miles per hour could travel a distance of over 1100 feet before they were able to properly maneuver their cars in response to an obstacle, yet a worker wearing a white shirt isn't visible to drivers until they are within well under 300 feet of the car.[4]

Look to 3M

When it comes to safety apparel, 3M is an industry leader in providing information, research, reflective applications, and garment design consultation. You and your workers can look to 3M for quality and reliability. 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.

IMPORTANT NOTICE TO USER:
LIMITED WARRANTY: In the event any 3M™ Scotchlite™ Reflective Material is found to be defective in material, workmanship, or not in conformation with any express warranty, 3M's only obligation and your exclusive remedy shall be to replace or refund the purchase price, at 3M's option, of such product upon timely notification thereof and substantiation that the product has been stored, maintained and used in accordance with 3M's written instructions.

EXCLUSIONS TO WARRANTY: THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTY OF QUALITY, EXCEPT OF TITLE AND AGAINST PATENT INFRINGEMENT.

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THE REMEDIES SET FORTH HEREIN ARE EXCLUSIVE.

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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