



Specification for Daytime Pedestrian Visibility Enhancement¹

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INTRODUCTION

The use of appropriate fluorescent marking materials can significantly enhance the daytime visibility and safety of the user. As one in a series addressing overall visibility for individual safety, this specification establishes minimum performance requirements and test methods for fluorescent and fluorescent-retroreflective marking materials (hereafter referred to as “material(s)”) used to enhance daytime pedestrian visibility.

1. Scope

1.1 This specification covers the daytime performance of fluorescent and fluorescent-retroreflective marking materials to be used on garments worn by pedestrians for the purpose of making them conspicuous to motorists. Garments include, but are not limited to, jackets, shirts, vests, coats, and coveralls. It allows for freedom of design of the materials so long as the minimum colorimetric and area requirements are met. This specification covers two fluorescent color regions for which high visibility materials have been widely studied and are widely available and used. It is anticipated that additional fluorescent color regions will be added to this specification as more information is developed on current and new materials. For a related standard covering visibility enhancement of pedestrians under nighttime conditions, see Specification E 1501.

1.2 This specification applies only to daytime illuminating and viewing conditions. The most common example is that of a motor vehicle operator viewing a pedestrian wearing the marked garment, illuminated by light from the sun and sky.

1.3 Conspicuity is a function of the contrast between an object and its immediate surroundings. The conspicuity of materials is related to the following:

1.3.1 High brightness, as measured by luminance factor.

1.3.2 High saturation, as measured by chromaticity coordinates.

1.4 High contrast between the marked object and its surround may be achieved by selecting size, shape, color, and

position of markings that have been determined to be effective.^{2,3,4}

1.5 This specification describes the minimum colorimetric performance of fluorescent and fluorescent-retroreflective materials intended to make an object conspicuous. It also addresses diminished performance of materials due to extended exposure to daylight. This is accomplished via laboratory accelerated weathering using a xenon-arc lamp fitted with borosilicate glass inner and outer filters to stimulate natural daylight.

1.6 SI (metric) units shall be used in referee decisions under this specification. The values given in parentheses are for information only.

1.7 *Although materials described in this specification are intended to enhance safety significantly through enhanced visibility under most conditions of illumination and viewing of the type described in 1.2, they do not guarantee that the user shall be conspicuous. Thus, this standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. The effectiveness of this standard in reducing death and injury has not been established.*

2. Referenced Documents

2.1 ASTM Standards:

E 284 Terminology of Appearance⁵

¹ This specification is under the jurisdiction of ASTM Committee E-12 on Appearance and is the direct responsibility of Subcommittee E12.08 on High Visibility Materials for Individual Safety.

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² Alferdinck, J.W.A.M. and Padmos, P., “Conspicuity of Fluorescent Colors for Safety Garments; a Literature Review,” Report No. IZF 1990 c-21/E, TNO Institute for Perception, Soesterberg, The Netherlands, 1990.

³ Lesley, Gary, “Enhancing the Daytime Conspicuity of Pedestrians Through the Usage of Fluorescent Materials,” *Color Research and Application*, Vol 20, No. 2, April 1995, p 117.

⁴ Burns, D.M. and Pavelka, L.A., “Visibility of Durable Fluorescent Materials for Signing Applications,” *Color Research and Application*, Vol 20, No. 2, April 1995, p. 108.

⁵ *Annual Book of ASTM Standards*, Vol 6.01.

- E 308 Practice for Computing the Colors of Objects by using the CIE System⁵
- E 808 Practice for Describing Retroreflection⁵
- E 991 Practice for Color Measurement of Fluorescent Specimens⁵
- E 1164 Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation⁵
- E 1247 Test Method for Identifying Fluorescence in Object-Color Specimens by Spectrophotometry⁵
- E 1345 Practice for Reducing the Effect of Variability of Color Measurement by Use of Multiple Measurements⁵
- E 1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional Geometry⁵
- E 1501 Specification for Nighttime Photometric Performance of Retroreflective Pedestrian Markings for Visibility Enhancement⁵
- F 923 Guide to Properties of High Visibility Materials Used to Improve Individual Safety⁵
- G 26 Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials⁶

3. Terminology

3.1 The appearance terms and definitions in Terminology E 284, Practice E 808, and Guide F 923 are applicable to this specification.

3.2 Definitions:

3.2.1 *contrast, n*—*subjective*, the degree of dissimilarity in appearance of two parts of a field of view seen simultaneously or successively.

3.2.2 *fluorescence, n*—a process by which radiant flux of certain wavelengths is absorbed and reradiated nonthermally at other, usually longer, wavelengths.

3.2.3 *luminance factor Y, n*—ratio of the luminance of a specimen to that of a perfect diffuser, when illuminated and viewed under specified geometric conditions.

3.2.4 *pedestrian, n*—any person on foot (standing or moving) who is located on a highway or street.

3.2.5 *retroreflection, n*—reflection in which the reflected rays are preferentially returned in directions close to the opposite of the direction of the incident rays, this property being maintained over wide variations of the direction of the incident ray.

3.2.6 *visibility, n*—the readiness with which an object or light source can be seen and distinguished under prevailing conditions.

3.3 Definitions of Terms Specific to This Standard:

3.3.1 *conspicuity, n*—the probability that an object will come to the attention of an observer.

3.3.1.1 *Discussion*—conspicuity depends upon characteristics of the object and its environment, including the area being searched and the time available to perform the search.

3.3.2 *fluorescent marking material, n*—a material exhibiting fluorescence, used for marking objects.

3.3.3 *fluorescent-retroreflective marking material, n*—a material exhibiting both fluorescent and retroreflective properties, used for marking objects to enhance their visibility.

3.3.4 *object, n*—the garment worn by a pedestrian, with markings for enhanced visibility under this specification.

4. Garment Types Covered by This Specification

4.1 Upper and lower body high visibility garments covered by this specification include but are not limited to vests, jackets, shirts, coats, pants, and coveralls.

5. Conspicuity Classes

5.1 Three conspicuity classes have been created as a guide for those involved in determining the appropriate amount of high visibility materials for garments. The descriptions for the classes are intended to assist the user with risk and exposure assessment. Each user situation should be evaluated on its own merits. The rationale for the three classes is based upon a performance/risk continuum that considers the degree of risk and exposure associated with the user's activities or occupation. Along with the degree of discretionary actions afforded the user, these are the main determinants for which class best suits the user's needs. The sketches shown in Fig. 1 are intended only to show an approximation of coverage for the three classes. In generating daytime conspicuity information at distances of 150 m (500 ft) or greater, observations have shown that minimum width of 7.6 cm (3 in.) may be necessary. The patterns appearing front and back, shall continue around the entire garment, ensuring enhanced visibility over all viewing angles. They represent upper-and lower-body garments, adult-sized large. For enhanced visibility when using Class 3, it is recommended that both pants and jacket or vest be used in combination. Placement of markings on lower arm and lower leg results in higher conspicuity for a person in motion.

5.1.1 *Conspicuity Class 1*—Conspicuity level for use in highly discretionary, recreational activities in clear, dry weather, with typical vehicle speeds of 75 kph (45 mph) or less and typical distances less than 150 m (500 ft). Example: a jogger or walker along a suburban street or parkway.

5.1.2 *Conspicuity Class 2*—Conspicuity level for use in recreational or occupational activities desiring greater visibility for inclement weather conditions, or for speeds, and distances, and risk levels exceeding those in Class 1. Example: survey crews, certain utilities and delivery work, runners in foul-weather gear, etc.

5.1.3 *Conspicuity Class 3*—Conspicuity level for use in high-risk occupations where the users are exposed repeatedly to traffic in a wide range of weather conditions, clearly placing them in danger. The wearer should be conspicuous through the full range of body motions at a minimum of 300 m (1000 ft) and identifiable as a person. Example: Construction workzone and traffic control personnel.

5.2 Caps or hats, although not included in 4.1 or shown in Fig. 1, are important to mark because when a portion of the wearer is masked by materials, equipment, vehicles, foliage, etc., the head is often visible. An example often observed is a person walking between parked cars.

6. Performance Requirements

6.1 *Requirements on Sizes of Materials*—Since pedestrian safety garments can exist in a wide range of styles and sizes, this specification specifies how much material must be used in

⁶ Annual Book of ASTM Standards, Vol 14.02.