Designation: E 1809 – ~~96~~01

Standard Test Method for Measurement of High-Visibility Retroreflective-Clothing Marking Material Using a Portable Retroreflectometer[1]

This standard is issued under the fixed designation E 1809; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the measurement of the retroreflective properties of high visibility pedestrian garments, such as vests, using a portable retroreflectometer that can be used in the field. The portable retroreflectometer is a hand-held instrument with a defined standard geometry ~~corresponding to United States usage~~ that can be placed in contact with retroreflective marking material to measure the retroreflection. The measurements can be compared to minimum requirements to determine the need for replacement of the retroreflective material.

1.2 This test method is designed for measuring retroreflective marking materials that have an area equal to or greater than that of the aperture of the retroreflectometer.

1.3 This test method is intended to be used for field measurement of retroreflective marking materials, but may be used to measure the performance of materials before placing the clothing in use.

1.4 *This standard does not purport to address all of the safety concerns, 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 284 Terminology of Appearance[2]

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[1] This test method is under the jurisdiction of ASTM Committee E~~-~~12 on Color and Appearance and is the direct responsibility of Subcommittee E12.10 on Retroreflection.

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E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods[3]
E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[3]
E 808 Practice for Describing Retroreflection[3]
E 809 Practice for Measuring Photometric Characteristics of Retroreflectors[2]
E 810 Test Method for Coefficient of Retroreflection of Retroreflective Sheeting[2]

3. Terminology

3.1 The terminology used in this test method, in general, agrees with that used in Terminology E 284.

3.2 *Definitions*—The delimiting phrase *in retroreflection* applies to each of the following definitions when used outside the context of this or other retroreflection standards.

3.2.1 *coefficient of retroreflection*, R_A, *n—of a plane retroreflecting surface*, the ratio of the coefficient of luminous intensity (R_I) of a plane retroreflecting surface to its area (A), expressed in candelas per lux per square metre ($cd \cdot lx^{-1} \cdot m^{-2}$).

$$R_A = R_I/A \tag{1}$$

3.2.2 *entrance angle*, β*datum axis*, *n*—angle between—a designated half-line from the illumination axis and retroreflector center perpendicular to the retroreflector axis.

3.2.3 *entrance angle,* β, *n*—the angle between the illumination axis and the retroreflector axis.

3.2.4 *entrance half-plane*, *n*—the half-plane that originates on the line of the illumination axis and contains the retroreflector axis.

3.2.5 *instrument standard*, *n*—a working standard used to standardize the portable retroreflectometer.

3.2.46 *observation angle*, *n*—the angle between the illumination axis and the observation axis.

3.2.57 *observation half-plane, n*—the half-plane that originates on the line of the illumination axis and contains the observation axis.

3.2.8 *orientation angle,* ω_s, *n*—the angle in a plane perpendicular to the retroreflector axis from the entrance half-plane to the datum axis, measured counter-clockwise from the viewpoint of the source.

3.2.9 *portable retroreflectometer*, *n*—a hand-held instrument that can be used in the field or in the laboratory to measure retroreflection.

3.2.59.1 *Discussion*—In this test method, *portable retroreflectometer* refers to a hand-held instrument that can be placed in contact with retroreflective marking material to measure the coefficient of retroreflection in a standard geometry.

3.2.610 *presentation angle,* γ, *n*—angle between—the dihedral angle from the observation entrance half-plane and to the half-plane that originates on observation half-plane, measured counter-clockwise from the illumination axis and that contains viewpoint of the retroreflector axis.
3.2.7 source.

3.2.11 *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 rays.

3.2.812 *rotation angle,* ϵ, *n*—angle indicating the orientation of the specimen when it is rotated about the retroreflector axis.
3.2.8.1 *Discussion*—The rotation—the angle is in a plane perpendicular to the dihedral angle retroreflector axis from the observation half-plane originating on to the retroreflector axis and containing datum axis, measured counter-clockwise from the positive part viewpoint of the second axis to the half-plane originating on the retroreflector axis source.

3.3 Definitions of entrance angle components β_1 and containing the datum mark. Range: − 180° < ϵ ≤ 180°. β_2, as well as other geometrical terms undefined in this test method, may be found in Practice E 808.

4. Summary of Test Method

4.1 This test method involves the use of commercial portable retroreflectometers for determining the retroreflectivity of retroreflective marking material(s) on garments.

4.2 Unless otherwise specified by the user, the
4.2 The entrance angle shall be 5 nominally −4.0° and the observation angle shall be 0.33°.
4.2.1 The angles specified are those currently employed in the United States and may differ from angles used in other countries. 0.2°.

4.3 The portable retroreflectometer uses an instrument standard for standardization.

4.4 After standardization, the retroreflectometer is placed in contact with the retroreflective marking material to be tested. Ensure material, ensuring that only the area to be tested is within the measurement area of the instrument. The retroreflective marking material and garment must be laid flat as a reading can be taken only on a planar surface.

4.5 The reading displayed by the retroreflectometer is recorded. The retroreflectometer is then moved to another position on the same retroreflective marking material and the measured value at this location is recorded. For each type and color of retroreflective marking material, fonr each side (front, back, left, and front right) of each the garment to be tested, under test, a minimum of five

[2] *Annual Book of ASTM Standards*, Vol 06.01.
[3] *Annual Book of ASTM Standards*, Vol 14.02.

readings shall be taken and their average of each set of readings shall be recorded. value reported.

5. Significance and Use

5.1 Measurements made by this test method are related to visual observation the night time brightness of retroreflective marking material as seen by materials approximately facing the human eye when illuminated by light sources such as driver of a moid-sized autor vmobile equipped with tungsten fielame'snt headlights at about 200 m distance.

5.2 Retroreflective marking material used for pedestrian safety can degrade with time, exposure to sunlight, wear and cleaning, and the material requires periodic measurement to ensure that the performance of the retroreflective material provides adequate safety to the wearer.

5.3 This test method is not intended to be used for the measurement of retroreflective marking material for pedestrian safety at observation and entrance angles other than those specified herein.

5.3.1 For most materials, the values for the coefficient of retroreflection obtained at −4° entrance angle and 0.2° observation angle using this test method will be nearly the same as the values corresponding to +5° entrance angle and 0.2° observation angle, a geometry that is specified in some high-visibility clothing standards.

6. Apparatus

6.1 *Portable Retroreflectometer*:

6.1.1 The retroreflectometer shall be portable with the capability of being placed at various locations on the retroreflective marking material.

6.1.2 The retroreflectometer shall be constructed so that its placement on the retroreflective marking material will prevent stray light from entering the measurement area of the instrument and affecting the reading.

6.2 Instrument standard or standards of desired color(s) and material(s) are required.

6.3 *Light Source Requirements*:

6.3.1 The projection optics shall be such that the illuminance at any point over the measurement area shall be within 10 % of the average illuminance.

6.3.2 The aperture angle of the source, as determined from the center of the measurement area, shall be not no greater than 0.1°.

6.4 *Receiver Requirements*:

6.4.1 The receiver shall have sufficient sensitivity and range to accommodate coefficient of retroreflection values from 0.1 to 1999 candelas per lux per square metre (cd lx^{-1} m^{-2}).

6.4.2 The combined spectral distribution of the light source and the spectral responsivity of the receiver shall match the combined spectral distribution of CIE Illuminant *A* and the
V (λ) spectral luminous effitciency function according to the following criterion: for For any choice of plano-parallel colored absorptive filter mounted in front of a white retroreflective sample, the ratio of the R_A measured with the filter to the R_A measured without the filter shall be within 10 % of the Illuminant *A* luminous transmittance of an air-spaced pair of two such filters.

6.4.2.1 In the retroreflectometer, the

6.4.2.1 The filter should be mounted with a downward tilt (for example, 1.0°) to avoid specular reflection into the receiver.

6.4.3 The receiver aperture of the retroreflectometer.

6.4.3 The instrument may be either circular a point instrument or an annular instrument, depending on the shape of the receiver aperture (see Fig. 1). Point and annular instruments make geometrically different measurements of R_A, which may produce values differing on the order of 10 %. Both measurements are valid for most purposes, but the user should learn the type of instrument from its specifications and be aware of certain differences in operation and interpretation. For both instrument types, the up position of the instrument shall be known.

6.4.3.1 The point instrument makes an R_A measurement virtually identical to an R_A measurement made on a range instrument following the procedure of Test Method E 810. The denoted −4° entrance angle would be set on a range instrument by setting β_1= −4°; β_2= 0°. The rotation angle (ϵ) for the point instrument is determined by the angular position of the instrument on the retroreflective marking. Assuming the retroreflector's datum axis to be upward, the rotation angle equals 0° when the instrument is upright. Clockwise rotation of the instrument on the retroreflective marking increases the rotation angle.

6.4.3.2 For the point instrument the up marking shall be opposite the entrance half-plane. It shall be in the observation half-plane (see Fig. 2).

6.4.3.1 For field measurements, the

6.4.3.3 The annular instrument makes an R_A measurement similar to an average of a greeat number of R_A measurements on a range instrument with presentation angle (γ) varying between −180° and +180°. For the denoted −4° entrance angle the range instrument would include the β_1 and β_2 settings indicated in Table 1. Table 1 includes the setting β_1= −4°; β_2= 0°, among others. There is no definite rotation angle (ϵ) for the preferred configuration since it (*a*) increases annular instrument. All values from −180° to +180° are subsumed in the measurement.

6.4.3.4 For the annular instrument the up marking shall be opposite the entrance half-plane (see Fig. 2).

6.4.3.5 For both instrument types, the orientation angle (ω_s) is determined by thpe angular position of the instrument and thus on the sensitivity, and (*b*) ensures that directionality effects, retroreflective marking. It is the rotation angle (ϵ) rather than the orientation angle (ω_s) which primarily affects retroreflection measured at the small 4° entrance angle.

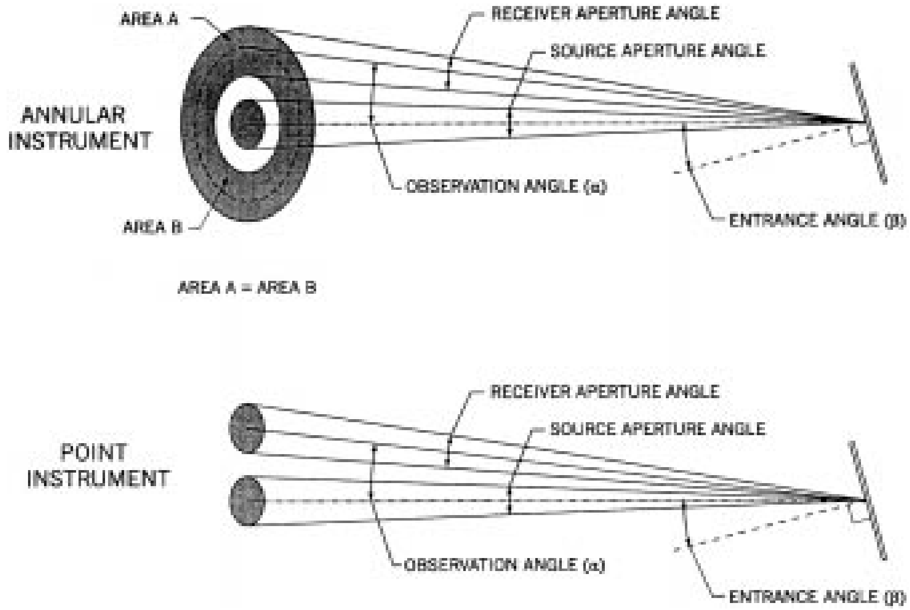
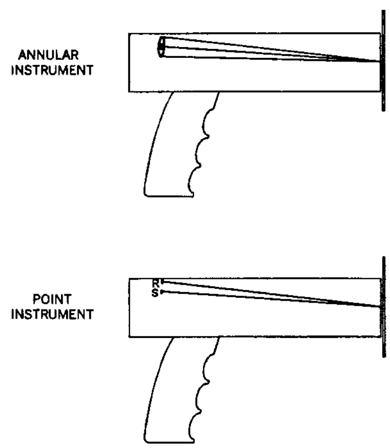


FIG. 1 Annular and Point Aperture Instrument Angles



NOTE 1—For each instrument type, the illumination beam is 4° downward. For the point instrument, receiver is above source.

FIG. 2 Upright Optical Schematics

6.4.3.6 Rotationally insensitive materials, such as glass bead materials, have R_A values that are ~~difficult to establish in~~ nearly independent of the ~~field,~~ rotation angle. Accordingly, the point and annular instruments will make practically identical measurements of R_A for retroreflective markings made with such materials.

6.4.3.7 Most prismatic retroreflectors are ~~minimized, thus improving repeatability.~~ ~~6.4.3.2 If evaluation~~ rotationally sensitive, having R_A values that vary significantly with rotation angle (ε), even at small entrance angles. The difference of R_A measurements made wi~~r~~th th~~e~~e two types of instrument on prisma~~l~~tic retroreflective markings may become as great as 25 % in extreme cases, but is generally on the order of ~~concern to~~ 10 %. Neither the ~~user,~~ magnitude no the direction of difference can be predicted for unknown samples. Thus, critical compar~~r~~ison of R_A values for prismatic retroreflective~~r~~ ma~~p~~rkings measured by instruments of the two types is not recommended.

6.4.3.8 A point instrument can gage the variation of R_A with rotation angle by placing it with different angular positions upon the retroreflective marking. R_A variation of 5 % for 5° rotation is not unusual. Accordingly, repeatable R_A measurement of prismatic retroreflective markings with a point instrument requires care in ang~~f~~ular positioning.

6.4.3.9 An annular instrument cannot gage the variation of R_A with rotation angle. Accordingly, repeatable R_A measurement of prismatic retroreflective markings with an annular instrument does not require care in angular positioning. Positioning to within ±15° is sufficient.

6.4.4 The aperture angle of the receiver ~~is~~ as determined from the measurement ~~area, and~~ area shall be ~~not~~ no greater than 0.1°. ~~For an annular aperture, the effective~~ The aperture angle of the receiver is measured ~~between the~~ from inner ~~and~~ to outer ring limits for annular receivers (see Fig. 1).

TABLE 1 Laboratory Emulation of Annular Instrument Geometry

α	β_1	β_2	ϵ
0.2°	3.86°	−1.03°	−165°
0.2°	3.47°	−2.00°	−150°
0.2°	2.83°	−2.83°	−135°
0.2°	2.00°	−3.46°	−120°
0.2°	1.04°	−3.86°	−105°
0.2°	0.00°	−4.00°	−90°
0.2°	−1.04°	−3.86°	−75°
0.2°	−2.00°	−3.46°	−60°
0.2°	−2.83°	−2.83°	−45°
0.2°	−3.47°	−2.00°	−30°
0.2°	−3.86°	−1.03°	−15°
0.2°	−4.00°	0.00°	0°
0.2°	−3.86°	1.03°	15°
0.2°	−3.47°	2.00°	30°
0.2°	−2.83°	2.83°	45°
0.2°	−2.00°	3.46°	60°
0.2°	−1.04°	3.86°	75°
0.2°	0.00°	4.00°	90°
0.2°	1.04°	3.86°	105°
0.2°	2.00°	3.46°	120°
0.2°	2.83°	2.83°	135°
0.2°	3.47°	2.00°	150°
0.2°	3.86°	1.03°	165°
0.2°	4.00°	0.00°	180°

6.4.5 The combined stability of the output of the light source and receiver shall be such that readings do not change more than 1 % after 10 s when the retroreflectometer is in contact with the retroreflective marking material.

6.4.6 The linearity of the retroreflectometer photometric scale over the range of readings expected shall be within 2 %. Correction factors may be used to ensure a linear response. A method for determining linearity is given in Annex A2 of Practice E 809.

6.5 *Measurement Geometry*:

6.5.1 The geometry used to determine the photometric performance shall be in accordance with Practice E 808.

6.5.2 The light source and receiver shall be ~~focused~~ at optical infinity and ~~the~~ possess an observation angle ~~shall be 0.33° ± 0.02°~~ of 0.2° ±0.01° as measured from the center of the source aperture to the centroid of responsivity of the receiver at all presentation angles. For annular receivers, the observation angle is taken as the angular distance when area *A* and area *B* are equal (see Fig. 1).

6.5.~~2~~3 The entrance angle of the light source shall be ~~5°~~ −4° ± 1°.

~~6.5.3 The presentation or rotation angle of the retroreflectometer shall be either 0° or 360° (annular) and shall be stated in the instrument specifications.~~

6.5.4 The diameter of the measurement area shall be not greater than 28 mm.

7. Standardization

7.1 The retroreflectometer shall be standardized using ~~its~~ an instrument standard consisting of a separate panel or disc of a material with a known ~~and reproducible coefficient of retroreflection at the prescribed geometry. The instrument standard must be standardized in accordance with Test Method E 810 with the datum mark indicated or fixed on the standard. In assigning the final value, presentation or rotation angle effects must be accounted for as in 7.1.1 or 7.1.2. The standardization values shall be maintained by checking against other standards or using Test Method E 810 sufficiently often to ensure that no large uncertainties in the measurement can occur.~~

~~7.1.1 If an annular receiver is used, the standardization value of the instrument standard shall be assigned by averaging the~~ R_A value~~s~~. The calibration values shall be maintained by checking against ~~15°~~ other standards or by laboratory recalibration sufficiently often to ensure that no large uncertainties in the measurement can occur.

7.1.1 Instrument standards are generally of ~~rotation angle through 165° rotation with~~ glass-bead sheeting construction. The glass-bead sheeting instrument standard shall be calibrated in the ~~presentation angle constant~~ laboratory range instrument at α = 0.2°; β_1~~8~~= −4°; β_2= 0°; ϵ = 0°. The glass-bead sheeting instrument standard must have a datum mark for the ~~entrance angle at 5°.~~ calibration laboratory, but this mark is not required for its use with either type of instrument.

7.1.2 If prismatic materials will be used as standards, they shall be calibrated differently for the two types of instrument.

7.1.2.1 A prismatic standard for a ~~e~~ point instrument shall be calibrated following the procedure of Test Method E 810. It shall be calibrated i~~v~~n the laboratory range instrument at α = 0.2°; β_1= −4°; β_2= 0°; ϵ = 0°.

(*a*) The prismatic instrument standard must have a datum mark for the calibration laboratory, and this mark is ~~used,~~ required for its use with the ~~standardization value~~ point instrument. The datum mark shall align with the up direction of the instrument. As noted in 6.4.3.8 the alignment to within a 5 degree rotation angle is important with prismatic samples, and should be held to especially when standardizing the point instrument with a prismatic standard.

7.1.2.2 A prismatic standard for an annular instrument shall be calibrated in the laboratory range instrument at the angles given in Table 1. The calibration involves twenty-four R_A measurements, which values are then averaged to produce the calibration R_A value ~~obtained~~ for ~~a rotation angle of 0°, presentation angle of 180° and entrance angle of 5°.~~

~~7.2 The~~ the instrument standard.

(*a*) The prismatic instrument standard ~~shall~~ must have ~~sufficient stability~~ a datum mark for the calibration laboratory, and ~~should~~ this mark may be required for its use with the annular instrument. In this case, the datum mark shall align with the up direction of the ~~same optical construction (beaded or microprismatic) and~~ instrument. The user shall determine by experimentation whether it is required. If the ~~same, or very similar, color as~~ instrument's R_A measurements of the ~~retroreflective marking material to~~ prismatic standard made at many rotations covering 360° do not differ by more than 3 %, then the standard's datum mark may be ~~measured. It shall have a known and constant retroreflectivity.~~ ignored in use. Greater variation is consistent with the annular instrument's specified geometry.

8. Procedure

8.1 Use the manufacturer's instructions for operation of the retroreflectometer. Generally, the following procedure will be used:

8.1.1 Turn on the retroreflectometer and allow it to reach equilibrium.

8.1.2 Adjust the retroreflectometer for zero reading (0 ±2 in the least significant digit) without the instrument standard using either a black material or an internal shutter.

8.1.3 Place the retroreflectometer in contact with the appropriate instrument standard. Adjust the standardization control to the value of the standard. ~~In~~ For instruments using ~~only one instrument~~ a single standard or correction factors for different material types, follow the manufacturer's instructions on standardization.

~~8.1.4 For each type and color of retroreflective marking material, place~~

8.1.4 Place the retroreflectometer in contact with the retroreflective marking material, with the instrument's up direction aligned with the up direction of the marking. Ensure that the retroreflective marking material and garment are laid flat and that only the area to be tested is within the measurement area of the instrument.

8.1.4.1 For each type and color of retroreflective marking material, record the retroreflectometer readings in five non-overlapping, equally-spaced locations. Include readings in areas of suspected wear. Do this separately for each material on the front, the back, the left side, and ~~each~~ the right side of the same garment.

8.1.4.2 If the retroreflective marking material is too small to make five readings, take as many readings as possible that would not entail overlap and use the reduced number of readings to determine an average. When a given material type and color is made up of separate pieces of material, readings shall be made on all of the pieces on that part of the garment to determine an ~~average. Take additional readings in areas of suspected wear. Record~~ average.

8.1.4.3 Record the readings and locations on the garment where the measurements were made.

8.1.5 Repeat 8.1.4.1-8.1.4.3 for each retroreflective marking material to be measured. Before measuring a different material, use the appropriate instrument standard for standardization.

8.1.6 When measuring the retroreflective marking material on a garment, if required, clean the garment in accordance with manufacturer's instructions before taking and recording the readings.

9. Calculations

~~9.1 For each type and color of retroreflective marking material on each garment, individually~~

9.1 Individually compute the average R_A for each type and color of retroreflective marking material ~~on the front,~~ for each ~~material on~~ of the four sides (front, back, left, and ~~each material on each side~~ right) of ~~th~~ each garment tested.

10. Report

10.1 Report the following information:

10.1.1 The test date.

10.1.2 The garment identification number and other identification including color, type, and age.

10.1.3 The model, serial number, type and age of the instrument used.

10.1.4 The average coefficient of ~~at least five readings, taken~~ retroreflection (R_A) expressed in candelas per lux per square metre for each type and color of retroreflective marking material, ~~on~~ for each of the ~~front, the~~ four sides (front, back, left, and ~~each side~~ right) of the ~~garment expressed as candelas per lux per square metre of retroreflective material.~~ garment. Indicate the number of readings used to determine each average R_A and show on a drawing of the garment where the measurements were ~~made and include~~ made, including dimensions where appropriate.

10.1.5 Remarks as to overall conditions of the retroreflective marking materials that adversely affect garment performance, such as delamination, wrinkles, discoloration, holes, and rips.

10.1.6 A statement as to whether the retroreflectometer used in the measurement utilizes an annular or ~~circular~~ point receiver aperture.

11. Sources of Error

11.1 There are many factors that cause high variability in readings taken in the field.

11.1.1 AStray light entering the instrument will produce readings that are higher than thee true values.

11.1.2 Readings taken from retroreflective markings that do not complertely fill the measurement area of the instrument will average be lower than the true values.

11.1.3 Annular instruments will effectively average several R_A values; see Table 1. For materials exhibiting variation of R_A with rotation or presentation angles, the values from annular receiver apertured retroreflectometers instruments may differ from the values for circular receiver apertured instruments.

12. Precision and Bias

12.1 The calculations, results, and terminology used to prepare this statement were drawn from Practice E 691. Three parameters were considered when analyzing the precision of a measurement of the coefficient of retroreflection using this test method: the level or magnitude of the measurement, the color of the sample, and the type of retroreflective marking material (glass bead or prismatic).

12.2 Measurements from four different retroreflective marking materials were evaluated. Specimens were prepared as 2 in. wide strips sewn onto the front, back, left side, and right side of T-shirts. The shirts that were laundered before being tested were washed and dried in conditions normally used in a typical home in the United States.

12.3 The number of retroreflectometers included in the study was four. Three of the retroreflectometers were annular instruments and the fourth was a point instrument. Each instrument was used by a single operator, who ran the test method two times within a single day.

12.4 *Precision*—The precision mean values ($\bar{x}$) for the coefficient of retroreflection for each type and color of retroreflective marking material, before and after laundering, are displayed in Table 2. The mean values were determined by averaging the means obtained for each material from the front, back, left side, and right side of the garment. Similarly, the within operator-retroreflectometer repeatability standard deviations (s_r) and the between operator-retroreflectometer reproducibility standard deviations (S_R) also shown in Table 2 were derived by pooling the respective values of the standard deviation obtained from the four sides of the garment. The last two columns of Table 2 list the corresponding 95 % repeatability (*r*) and reproducibility (*R*) limits on the difference between two test results (see Practice E 177).

12.4.1 The R_A values measured for the Yellodw Prismatic-High R_A retroreflective markings using the annular instruments systematically exceeded the values recorded by the point instrument by about 25 % (see 6.4.3.7 for a possible explanation of this difference). Therefore, the mean, standard deviations, and 95 % limits given for this material type were based on data obtained only from the annular instruments. For comparison, the mean determined for this material using only the point instrument is also given.

12.25 *Bias*—Since there is no standard for the measurement, its bias, if any, cannot be determined.

13. Keywords

13.1 coefficient of retroreflection; high visibility materials; portable retroreflectometer; retroreflection; retroreflective garments; retroreflectors

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

TABLE 2 Coefficient of Retroreflection (R_A)[A]—Precision Statistics

	Material	$\bar{x}$	S_r	S_R	r	R
New	Silver Beaded	494	4.4	14.6	± 12	± 41
	Red-Orange Prismatic	194	15.2	19.0	± 43	± 53
	Yellow Prismatic—Low R_A	98	8.2	8.8	± 23	± 25
	Yellow Prismatic—High R_A	725[B](558[C])	6.6[B](6.6[C])	15.5[B]	± 18[B](±18[C])	± 43[B]
Washed	Silver Beaded	469	13.2	13.5	± 37	± 38
	Red-Orange Prismatic	122	5.0	12.8	± 14	± 36
	Yellow Prismatic—Low R_A	32	2.6	3.7	± 7.3	± 10
	Yellow Prismatic—High R_A	712[B](569[C])	20.5[B](22.9[C])	20.5[B]	± 57[B](±64[C])	± 57[B]

[A]Candelas/lux/square metre.
[B]Calculated using data measured by annular instruments only.
[C]Calculated using data measured by point instrument only.