The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
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# SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1967

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## (R) Retroreflective Materials for Vehicle Conspicuity

***1. Scope-—***This SAE Recommended Practice applies to retroreflective materials that are used on truck tractors and trailers 2032 mm or more in overall width and with a Gross Vehicle Weight Rating (GVWR) over 4536 kg, and school buses. The retroreflective materials for the truck tractors and trailers are super-high-intensity materials containing microprisms. The retroreflective materials for school buses may contain flexible non-exposed glass bead lens or microprisms.

**1.1 Purpose—**This document establishes test procedures and related requirements for identifying and evaluating retroreflective materials intended for use in passive devices used to enhance the conspicuity of vehicles at nighttime.

Conspicuity materials meeting the requirements of this document are intended to be in compliance with FMVSS-108 which references ASTM D 4956 Type V materials. The specifications in this document are not intended to apply to materials used for commercial identification, advertising, or similar graphics. Their use is outside the scope of this document. School bus retroreflective materials specified in this document are intended to comply with the requirements of FMVSS-217 and FMVSS-131.

***2. References***

**2.1 Applicable Publications—**The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of referenced publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J576—Plastic Materials for Use in Optical Parts Such as Lenses and Reflectors of Motor Vehicle Lighting Devices
SAE J759—Lighting Identification Code
SAE J2139—Tests for Lighting Devices and Components Used on Vehicles 2032 mm or More in Overall Width

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117—Method of Salt Spray (Fog) Testing
ASTM D 4956—Standard Specification for Retroreflective Sheeting for Traffic Control





**TO PLACE A DOCUMENT ORDER; (724) 776-4970 FAX: (724) 776-0790**
**SAE WEB ADDRESS http://www.sae.org**

2.1.3 FMVSS PUBLICATIONS—Available from the Superintendent of Documents, U. S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9320.

FMVSS 108—Lamps, Reflective Devices, and Associated Equipment
FMVSS 131—School Bus Pedestrian Safety Devices
FMVSS 217—Bus Emergency Exits and Window Retention and Release

**2.2 Related Publications—**The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 1347—Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry
ASTM E 1349—Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional Geometry
ASTM E 308—Test Method for Computing the Colors of Objects by Using the CIE System
ASTM E 810—Standard Test Method for Coefficient Retroreflection of Retroreflective Sheeting
ASTM E 1164—Standard Practice for Obtaining Spectrophotometric Data for Object-Color Evaluating
ASTM G-23—Recommended Practice for Operating Light and Water Exposure Apparatus (Carbon-Arc Type,) for Exposure of Non-Metallic Materials

2.2.2 GOVERNMENT PUBLICATIONS—Available from the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.

DOT-HS-806-098-(Department of Transportation)-Improved Vehicle Conspicuity and Signaling Systems; Task II, Vector Research
DOT-HS-807-815 (Department of Transportation) Performance Requirements for Large Truck Conspicuity Enhancements.

2.2.3 OTHER PUBLICATIONS

CIE 39-2 (TC-1.6)—(Commission Internationale de L'Eclairage/International Commission on Illumination) Recommendations for Surface Colours for Visual Signaling
Austin & Forrester; Visibility Characteristics of Large Vehicle Conspicuity Marking, October, 1988 (unpublished)

## *3. Definitions*

**3.1 Conspicuity—**The ability of an object to be noticed and recognized without confusion or ambiguity.

**3.2 Daytime—**The period when an object is illuminated primarily by natural sunlight, either direct or diffused by weather or clouds; the period when headlamps are not required for road illumination.

**3.3 Graphics—**Markings, illustrations, or other identifying devices on observable surfaces of a vehicle.

**3.4 Passive Devices—**Devices which require no electrical power or internal illumination, but which are instead made visible by retroreflection from external light sources.

**3.5 Nighttime—**The period when an object is illuminated solely or primarily by artificial light, such as the headlamps of the vehicle of the observer. The period when headlamps are required to be illuminated.

**3.6 Retroreflection—**The process by which illumination is returned by an object directly or generally back to the source of that illumination; reflection characterized by the flux in an incident beam being returned in directions close to the direction from which it came, this effect occurring over a wide range of incidence angles.

**3.7 Reflectance Factor—**Ratio of the flux reflected from the specimen to the flux reflected from a perfect reflecting diffuser under the same geometric and spectral conditions of measurement.

**3.8 Luminance Factor (Cap Y)—**ratio of the luminance of a specimen to that of a perfect diffuser, when illuminated and viewed under specified geometric conditions.

## *4. Lighting Identification Codes, Markings, and Notices*

**4.1** Conspicuity materials conforming to this document may be identified by the codes indicated in accordance with SAE J759 as follows:

a. TRUCKS AND TRAILERS

50 mm wide marked—SAE-A4
75 mm wide marked—SAE-A5
100 mm wide marked—SAE-A6

b. SCHOOL BUSES

25 mm wide marked—SAE-A7

**4.2** Certification markings no less than 3 mm high may appear at least once every 300 mm on the material surface. The markings shall be permanent in nature.

## *5. Tests*

### 5.1 Sample Preparation

5.1.1 Test Panels measuring 200 mm x 200 mm shall be prepared according to ASTM D 4956.

### 5.2 Salt Spray Resistance Test

5.2.1 TEST PROCEDURE—The test panels shall be subjected to 96 h exposure, comprising of two periods of 48 h each separated by a 2-h interval at 25 °C ± 5 °C during which the samples are allowed to dry, in accordance with ASTM B 117.

5.2.2 After completion of salt spray resistance test, the samples shall be tested for coefficient of retroreflection as specified in 6.7, and the color requirements and reflectance values as specified in 6.8.

### 5.3 Solvent and Fluid Resistance Test

5.3.1 TEST FLUIDS

a. Reference fuel (85% mineral spirits and 15% Xylene).
b. Diesel Fuel (ASTM-2D).
c. Truck/trailer wash detergent- an aqueous solution containing 10% TriSodium Phosphate (TSP).

5.3.2 TEST PROCEDURE—Immerse each test panel into all fluids, each for 10 s, 10 times, with 20 s evaporation period between each dip.

*5.3.2.1* After immersion, rinse the samples with water and dry with a clean lint free cloth.

5.3.3 After completion of the solvent and fluid resistance test, samples shall be tested for coefficient of retroreflection as specified in 6.7, and the color requirements and reflectance values as specified in 6.8.

**5.4 Weathering Test—**To determine that weathering characteristics will be at acceptable levels after a period of extended use, conspicuity materials must pass Test #1 for accelerated weathering test before they can be used. Conspicuity materials must pass the extended weathering test identified as Test #2 in order to show capability for extended use on vehicles under extreme environmental conditions.

5.4.1 TEST 1—Conspicuity materials shall be exposed for 2200 h in accordance with the procedures in ASTM D 4956.

5.4.2 TEST 2—Conspicuity materials shall be subjected to the 3 year outdoor exposure test in SAE J576.

**5.5 Impact Resistance Test—**The materials shall be subjected to the impact resistance test procedures in ASTM D 4956.

**5.6 Adhesion Test—**The material specimen shall be tested in accordance with the adhesion test specified in ASTM D 4956.

**5.7 Moisture Test—**The material specimen shall be tested in accordance with the moisture test specified in SAE J2139.

**5.8 Coefficient of Retroreflection—**The coefficient of retroreflection of the specimen material shall be determined in accordance with the test procedures in ASTM E 810. The values shall be specified in units of candelas per lux per square meter.

**5.9 Test for Daytime Color**

5.9.1 PREPARATION—Sample to be evaluated shall be placed on a flat substrate which shall be capable of being rotated through 360 degrees. Other preparations shall be in accordance with ASTM D 4956.

5.9.2 Color measurements shall be determined spectrophotometrically in accordance with ASTM D 4956 for red, white, and yellow materials.

## *6. Requirements*

**6.1 Salt Spray Resistance**

6.1.1 The retroreflective materials must show no discoloration or blistering after exposure to the test in 5.2 and loss of adhesion of no more than 1 mm from the edge.

6.1.2 After completion of salt spray resistance test, samples shall meet the requirements of Tables 1, 2, and 3 as applicable.

**6.2 Solvent and Fluid Resistance**

6.2.1 After immersion in each of the test fluids indicated in 5.3.1, the materials shall show no noticeable softening, dulling, color change, or loss of adhesion.

6.2.2 After completion of solvent and fluid resistance test, samples shall meet the requirements of Tables 1, 2, and 3 as applicable.

### 6.3 Weathering

6.3.1 TEST 1—After completion of the artificial weathering test described in 5.4.1, the material under test shall show no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, or more than 0.8 mm shrinkage or expansion and shall meet 80% of the photometric values indicated in Table 1 or Table 2 as applicable.

6.3.2 TEST 2—After being subjected to the 3 year outdoor weathering test specified in SAE J576, the material under test shall show no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, or more than 0.8 mm shrinkage or expansion and meet 50% of the photometric values indicated in Table 1 or Table 2 as applicable.

6.3.3 COLOR—After the weathering tests described in 5.4.1 and 5.4.2, materials shall meet the color requirements of 6.8.

**6.4 Impact Resistance—**Impact resistance of the materials shall meet the requirements specified in ASTM D 4956.

### 6.5 Adhesion

6.5.1 Retroreflective sheeting materials shall conform to the requirements for adhesion as specified in ASTM D 956 for the specified class of material.

**6.6 Moisture—**Retroreflective materials shall meet the moisture requirements specified in SAE J2139.

### 6.7 Coefficient of Retroreflection

6.7.1 When tested according to 5.8, the minimum reflective intensity values shall be those shown in Tables 1 or 2 as appropriate.

6.7.2 TRUCKS AND TRAILERS—The minimum reflective intensity for retroreflective materials used on trucks and trailers shall be as indicated in Table 1.

**TABLE 1—MINIMUM REFLECTIVE INTENSITY (CD/LX/M2)**

| Grade | Entrance Angle (degrees) | Observation Angle 0.2 Degrees White | Observation Angle 0.2 Degrees Red | Observation Angle 0.5 Degrees White | Observation Angle 0.5 Degrees Red |
|---|---|---|---|---|---|
| DOT-C2 | –4 | 250 | 60 | 65 | 15 |
| A4 | 30 | 250 | 60 | 65 | 15 |
| | 45 | 60 | 15 | 15 | 4 |
| DOT-C3 | –4 | 165 | 40 | 43 | 10 |
| A5 | 30 | 165 | 40 | 43 | 10 |
| | 45 | 40 | 10 | 10 | 3 |
| DOT-C4 | –4 | 125 | 30 | 33 | 8 |
| A6 | 30 | 125 | 30 | 33 | 8 |
| | 45 | 30 | 8 | 8 | 2 |

*6.7.2.1* The ratio of the luminous intensities of white and red shall not be less than 4:1 nor greater than 8:1.

6.7.3 SCHOOL BUSES—The minimum reflective intensity for retroreflective materials used on school buses shall be as indicated in Table 2.

**TABLE 2—MINIMUM REFLECTIVE INTENSITY (CD/LX/M2)**

| Grade | Entrance Angle (degrees) | Observation Angle 0.2 Degree White | Observation Angle 0.2 Degree Red | Observation Angle 0.2 Degree Yellow | Observation Angle 0.5 Degree White | Observation Angle 0.5 Degree Red | Observation Angle 0.5 Degree Yellow |
|---|---|---|---|---|---|---|---|
| GLASS BEAD | –4 | 250 | 45 | 170 | 95 | 15 | 62 |
| A7 | 30 | 150 | 25 | 100 | 65 | 10 | 45 |
| PRISMATIC | –4 | 250 | 45 | 170 | 200 | 28 | 136 |
| A7 | 30 | 95 | 13.3 | 64 | 65 | 10 | 45 |

### 6.8 Daytime Color

6.8.1 When tested according to 5.9, the average measured reflectance value shall meet the requirements in Table 3.

6.8.2 Red and white retroreflective materials shall be used for conspicuity treatments on trucks and trailers. The color coordinates shall be in accordance with Table 3.

6.8.3 Red, white, or yellow retroreflective materials shall be used for conspicuity treatments on school buses. The color coordinates shall be in accordance with Table 3.

**TABLE 3—COLOR TABLE**

| Color | Chromaticity Coordinates (Corner Points) 1 x/y | Chromaticity Coordinates (Corner Points) 2 x/y | Chromaticity Coordinates (Corner Points) 3 x/y | Chromaticity Coordinates (Corner Points) 4 x/y | Reflectance Limits %Y Min. | Reflectance Limits %Y Max. |
|---|---|---|---|---|---|---|
| WHITE | 0.303/0.287 | 0.368/0.353 | 0.340/0.380 | 0.274/0.316 | 15 | — |
| RED | 0.613/0.297 | 0.708/0.292 | 0.636/0.364 | 0.558/0.352 | 2.5 | 11 |
| YELLOW | 0.498/0.412 | 0.557/0.442 | 0.479/0.520 | 0.438/0.472 | 12 | 30 |

***7.*** ***Guidelines*****—**Surfaces where installation of retroreflective materials will be made, should be cleaned to remove dirt, moisture, and grease or oil that may be present, so that proper adhesion can occur.

***8.*** ***Notes***

**8.1** **Marginal Indicia—**The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.



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