Traffic Sign Retroreflectivity

Basics of Sign Retroreflectivity & New Sign Maintenance Requirements

Safe Roads for a Safer Future
Investment in roadway safety saves lives

U.S. Department of Transportation
Federal Highway Administration
Ground Rules

- Facilities
  - Restrooms, drinks, snacks, phones
  - Other considerations
- Cell phones and pagers on silent
- Ask questions and make comments to the group as they occur to you
- Be considerate of others
Welcome

- **Retroreflectivity is important!**
  - Importance has increased
  - Not a part of any educational curriculum
    - “OTJ” training
  - Your agency now responsible
Course Instructor(s)

- Names
- Short bio
Participant Introductions

- Name
- Agency
- Position/duties
Purpose of Course

Intended for Managers and Decision-makers

- Describe sign retroreflectivity concepts
- Understand nighttime visibility issues
- Summarize new requirements
- Describe retroreflectivity maintenance methods

An inspector training course is also available through your LTAP centers
## Content & Schedule

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Questions
Background Information
Why Do We Install Signs?

Required by MUTCD?  
NO

Engineering Decision?  
YES!

Why?

To help drivers  
(including older)

U.S. Department of Transportation  
Federal Highway Administration
Key Issue: Older Drivers

- 18.9 million drivers age 70+ in 2000
- 20.6 million drivers age 70+ in 2006
  - 48% increase from 1990 to 2006
    - 1990 — 8% of drivers were 70+
    - 2006 — 10.2% of drivers were 70+
- “Older” driver population will continue to grow as baby-boomers age
MUTCD applies to all roads “open to public travel”

- includes toll roads and roads within shopping centers, parking lots, airports, sports arenas, and other similar business and recreation facilities that are privately owned but where the public is allowed to travel without access restrictions. *pending rulemaking process*
Manual on Uniform Traffic Control Devices

Section 2A.06 – Design of Signs

- The basic requirements of a highway sign are that it be legible to those for whom it is intended and that it be understandable in time to permit a proper response. Desirable attributes include:
  - High visibility by day and night; and
  - High legibility (adequately sized letters or symbols, and a short legend for quick comprehension by a road user approaching a sign).

Section 2A.08 – Retroreflectivity or Illumination

- …signs shall be retroreflective or illuminated to show the same shape and similar color by both day and night, unless specifically stated otherwise...
- The requirements for sign illumination shall not be considered to be satisfied by street or highway lighting.

The responsibility for the design, placement, operation, maintenance, and uniformity of traffic control devices shall rest with the public agency or the official having jurisdiction.
Sign Purpose: Promote Highway Safety

Reasonably safe for day or night travel?

MUTCD Principles:
• Fulfill a need;
• Command attention;
• Convey a clear, simple meaning;
• Command respect from road users; and
• Give adequate time for proper response.
Night Travel and Crashes

Fatalities per Million Miles Traveled (2004-2006)

Nighttime vs. Daytime

Source: National Safety Council

U.S. Department of Transportation
Federal Highway Administration
Nighttime Driving

**Daytime**
- Many cues available
- Driver task relatively easy

**Nighttime**
- Few cues remain
- Task more difficult

*Retroreflectivity provides nighttime guidance*
Retroreflective Signs

Daytime signing here is complimentary

Nighttime signing here is necessary
Typical Outdoor Durability Testing

- Type I
- Type II
- Type III

Retroreflectivity vs. Age (months)

45 degree south facing
Degraded Stop Sign..
“Safety” of Sign Upgrades

- Mendocino County, CA – Steve Ford
- City of Sioux City, IA – Scott Carlson
- ICBC, Vancouver, B.C. – John Pump
- Putnam County, NY – Mike Druckreier

Source: Douglas A. Ripley
2005 TRB Annual Meeting
Howard R. Green Company
Summary of “Safety” Studies

- **Sioux City** –
  - City-wide Application
  - **Reported crash reductions**
  - Day/Night Ratio
  - 34:1 B/C
  - Program continued

- **Putnam County**
  - Spot Locations
  - 25% reduction in crashes
  - 50% reduction in nighttime
  - Crash Types
  - Program continued

- **Mendocino County**
  - Spot Locations
  - 42% reduction in crashes
  - Program continued

- **ICBC**
  - Each Crash prevented has **positive cost-benefit ratio**
  - Program expanded

**U.S. Department of Transportation**
**Federal Highway Administration**
Safety of Stop Sign Upgrades

- Stop signs upgraded in South Carolina and Connecticut
- Before-and-after study conducted
- Mixed findings but cost effective at lower-volume intersections
- FHWA-HRT-08-041
Sign and Pavement Marking Improvements Reduce Crashes

According to the National Highway Traffic Safety Administration, in 2004 rural roads accounted for approximately 37 percent of all fatal crashes. Contributing factors on secondary roads include sharp curves, no shoulders, no pavement markings, and inconsistent signing. Mendocino County in the county roads (approximately 220 miles), identifying potential signing and marking deficiencies, recommending changes based on the current California Department of Transportation (Caltrans) signing and marking guidelines, and implementing the results. During recurring three-year cycles, all arterials,

1993 DOT Appropriations Act
“The Secretary of Transportation shall revise the MUTCD to include a standard for a minimum level of retroreflectivity that must be maintained for traffic signs and pavement markings which apply to all roads open to public travel.”
Why Create Minimums?

Daytime

Nighttime

U.S. Department of Transportation
Federal Highway Administration
Retroreflectivity Concepts
RETROreflection

Matte or Diffuse Reflection

Mirror-like Reflection (Specular)

Retroreflection

U.S. Department of Transportation
Federal Highway Administration
Retroreflection
Informal Definition

● A ratio of the amount of light returned from a sign versus the amount hitting the sign
● A way to measure the efficiency of a material

\[
\frac{\text{Light OUT of sign}}{\text{Light INTO sign}} = \text{Retroreflectivity}
\]
Glass spheres and microsized prisms are the current technologies used to make sign materials retroreflective.

The light is returned to the source in a cone shaped pattern.
Sign Sheeting Materials

- **Engineering Grade**
- **Hi-Intensity Beaded**
- **Microprismatic**
Sign Sheeting

**Exposed Lens Sheeting**
(First Retroreflective Sheeting)

- Durable Plastic Resin
- Glass Beads
- Adhesive
- Protective Liner
- Metallic Reflector
- Water

**Enclosed Lens Sheeting**
(Types I & II – e.g. Engineering Grades)

- Durable Transparent Plastic
- Glass Bead
- Precoated Adhesive
- Protective Liner
- Metallic Reflector Coat

U.S. Department of Transportation
Federal Highway Administration
Sheeting Types

Encapsulated Lens Sheeting
(Type III – e.g. High Intensity)

Prismatic Lens Sheeting

U.S. Department of Transportation
Federal Highway Administration
Video Demonstration

SCHOOL BUS STOP AHEAD
Retroreflectivity Cone

Reflected light is brighter near light axis

Reflected light gets dimmer as distance from light axis increases

Light Source Direction

Retroreflector
Greg will get sample materials
Cone Size is Important

Cone of Retroreflection
Technical Terms

- **Luminance** ($cd/m^2$)
- **Retroreflective Sign** ($R_A cd/lx/m^2$)
- **Illuminance** ($lx$)
Basic Angles of Retroreflectivity

- **Observation Angle** – Where in the cone is the measurement made (from the light source).

- **Entrance Angle** – What is the orientation of the sign or pavement marking (is from the light source).
Key Geometry Angles

**Observation angle** ($\alpha$)
Between source and receptor (red and blue lines)

**Entrance angle** ($\beta$)
Between source and target axis (blue and green lines)

Perpendicular to sign
Penlight Demonstration

Photo of demo signs

More dim
Dimmer
Bright

Demo

U.S. Department of Transportation
Federal Highway Administration
Sheeting Specification Geometry

Example: ASTM D4956

<table>
<thead>
<tr>
<th>Observation Angle</th>
<th>Entrance Angle</th>
<th>White</th>
<th>Yellow</th>
<th>Orange</th>
<th>Green</th>
<th>Red</th>
<th>Blue</th>
<th>Brown</th>
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<tbody>
<tr>
<td>0.1°</td>
<td>−4°</td>
<td>300</td>
<td>200</td>
<td>120</td>
<td>54</td>
<td>54</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>0.1°</td>
<td>+30°</td>
<td>180</td>
<td>120</td>
<td>72</td>
<td>32</td>
<td>32</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>0.2°</td>
<td>−4°</td>
<td>250</td>
<td>170</td>
<td>100</td>
<td>45</td>
<td>45</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>0.2°</td>
<td>+30°</td>
<td>150</td>
<td>100</td>
<td>60</td>
<td>25</td>
<td>25</td>
<td>11</td>
<td>8.5</td>
</tr>
<tr>
<td>0.5°</td>
<td>−4°</td>
<td>95</td>
<td>62</td>
<td>30</td>
<td>15</td>
<td>15</td>
<td>7.5</td>
<td>5.0</td>
</tr>
<tr>
<td>0.5°</td>
<td>+30°</td>
<td>65</td>
<td>45</td>
<td>25</td>
<td>10</td>
<td>10</td>
<td>5.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

A Minimum Coefficient of Retroreflection ($R_A$) cd/ft²(cd·lx⁻¹·m⁻²).

B Values for 0.1° observation angle are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.
Questions
Summary

- Does retroreflectivity by itself describe how bright a sign will look?

- Everything else equal, how will a driver in a sports car see a nighttime sign versus a driver in a big truck?
How Retroreflection = Nighttime Visibility
Key Elements of Visibility

Headlamp Illuminance x Sign Material Retroreflectivity = Luminance

...but that’s not all !!
The “Older Driver” Factor

Luminance \times \text{Driver Vision} = \text{Perceived Brightness}
Key Nighttime Visibility Issues

- **Sign**
  - Location
  - Sheeting materials
- **Headlamps**
  - Amount of light for signs
- **Driver**
  - Visual capabilities
  - Comfort level
- **Vehicle**
  - Size
Key Issue: Headlamps

- Out of control of traffic engineers
- Evolving considerably in last decades
Headlamps

- Sealed Beam Pattern
- Modern Cutoff Pattern
Impacts of Headlamps

**Headlamp Year**

- 2000
- 1997
- 1980s

**Distance to Sign (ft)**

**Luminance**

**Typical overhead guide sign**

U.S. Department of Transportation
Federal Highway Administration
Cone Size is Important

Cone of Retroreflection
Key Issue: Drivers

- 20.6 million drivers age 70+ in 2006
  - 48% increase from 1990 to 2006
    - 1990 — 8% of drivers were 70+
    - 2006 — 10.2% of drivers were 70+
Example 1

6 different types of material used on these Stop signs
Example 2

7 different types of material used on these Stop signs
Can you see the sign?
New Requirements

MUTCD Sign Retroreflectivity
Maintenance Requirements
Final Rule

- Published on Dec 21, 2007
  - Vol 72, No. 245
- Revision #2 of the 2003 Edition of the MUTCD
- Effective Jan 22, 2008
MUTCD Changes

- Portions of the MUTCD revised:
- Introduction
  - Compliance dates
- Part 1
  - 1A.11 - relation to other publications
- Chapter 2A
  - 2A.09 - minimum sign retroreflectivity
  - 2A.22 - sign maintenance
- Minor editorial changes to cross-references
  - 2A, 2B, and 6F
“Standard:
Public agencies or officials having jurisdiction shall use an assessment or management method that is designed to maintain sign retroreflectivity at or above the minimum levels in Table 2A-3”
“Support:
Compliance… is achieved by having a method in place and using the method to maintain the minimum levels established in Table 2A-3. Provided that… a method is being used, an agency would be in compliance… even if there are some individual signs that do not meet the… levels at a particular point in time.
New MUTCD Language

“…One or more of the following assessment or management methods should be used…”

- Visual Nighttime Inspection
  - Calibration Signs
  - Comparison Panels
  - Consistent Parameters
- Measured Sign Retro
- Expected Sign Life
- Blanket Replacement
- Control Signs
- Future Method Based On Engr. Study
- Combination Of Any
<table>
<thead>
<tr>
<th>Sign Color</th>
<th>Sheetig Type (ASTM D4956-04) ¹</th>
<th>Beaded Sheeting</th>
<th>Prismatic Sheeting</th>
<th>Additional Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>White on Green</td>
<td></td>
<td>I</td>
<td>II</td>
<td>III, IV, VI, VII, VIII, IX, X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W* G ≥ 7</td>
<td>W* G ≥ 15</td>
<td>W* G ≥ 25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W* G ≥ 7</td>
<td></td>
<td>W ≥ 250; G ≥ 25</td>
</tr>
<tr>
<td>Black on Yellow or Black on Orange</td>
<td></td>
<td>W* G ≥ 7</td>
<td></td>
<td>W ≥ 120; G ≥ 15</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ground-mounted</td>
</tr>
<tr>
<td>Black on White</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White on Red</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black on White</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

¹ The minimum maintained retroreflectivity levels shown in this table are in units of cd/lx/m² measured at an observation angle of 0.2° and an entrance angle of -4.0°.

² For text and fine symbol signs measuring at least 1200 mm (48 in) and for all sizes of bold symbol signs

³ For text and fine symbol signs measuring less than 1200 mm (48 in)

⁴ Minimum Sign Contrast Ratio ≥ 3:1 (white retroreflectivity ÷ red retroreflectivity)

* This sheeting type should not be used for this color for this application.
What do the numbers look like?

*Pictures do not represent retroreflectivity well*
Quiz

Which of these signs:
- Needs to be replaced?
- Is near the minimum retroreflectivity level?
- Is adequate and good for a few more years?
Quiz Answers

- Pictures of retro are sensitive to light and position of camera/flash
  - More light = brighter sign

- Example:
  - Same: *sign, camera, and camera/flash position*
  - Different: *flash intensity (amount of light)*
Exempt Signs

- Parking/Standing/Stopping
- Walking/Hitchhiking
- Adopt-A-Highway
- Blue or Brown Backgrounds
- Exclusive Use of Bikes or Peds

Note: Must still meet other requirements in MUTCD (inspections, retroreflective, etc.,)
Clarification

- Fluorescent colors
  - fluorescent yellow → yellow
  - fluorescent yellow-green → yellow
  - fluorescent orange → orange
Funding ... What is eligible

- **Sign Management Programs**: SPR funds and Community Safety Grants. HSIP also, if data supported with link to State’s Strategic Highway Safety Plan.

- **Sign Replacement**: Eligible Federal Aid Programs: NHS, STP, IM, and HSIP. Also High Risk Rural Roads.

- **IMPORTANT**: Specific eligibility requirements are determined locally. Please coordinate with partnering agencies: local MPO, State DOT, FHWA Highway Safety Office, and the local FHWA Division Office.
Compliance Periods

From “Effective” Date of Final Rule (January 22, 2008):

- Establish and implement method(s)
  - 4 yrs (January, 2012)

- Replace identified regulatory, warning, ground-mounted guide signs (except street-name)
  - 7 yrs (January, 2015)

- Replace identified street name & overhead guide signs
  - 10 yrs (January, 2018)
Summary of New Language

- Public agencies or officials having jurisdiction shall use an assessment or management method that is designed to maintain sign retroreflectivity at or above the minimum levels in Table 2A-3.

- Compliance... is achieved by having a method in place and using the method to maintain the minimum levels established in Table 2A-3. Provided that... a method is being used, an agency would be in compliance... even if there are some individual signs that do not meet the... levels at a particular point in time.
What Should I Do Next?

- Select maintenance method(s)
- Budget to implement method
- Train inspectors
- Implement maintenance method(s)
- Decide on sheeting types
  - Consider initial and life cycle costs
- Budget for future sign replacement
MUTCD Sign Maintenance Methods

How to be in Compliance with new Retroreflectivity Maintenance Requirements
Can we decide to replace signs based on daytime inspections?
MUTCD Methods

- Visual assessment
- Measured retroreflectivity
- Expected sign life
- Blanket replacement
- Control signs
- Future methods
- Combination of methods

www.fhwa.dot.gov/retro
Method 1: Visual Assessment

- Trained inspector
- Visual inspection at night
- Need to tie to minimum values by using
  - Calibration signs procedure, or
  - Comparison panels procedure, or
  - Consistent parameters
Method 1: Visual Assessment

- Common elements of all visual assessment techniques
  - Aim inspection vehicle headlamps
  - Two-person crew works best
  - Having an inventory is ideal
  - Use low-beam headlamps
  - Have evaluation form and criteria
  - Conduct evaluations at roadway speed
Method 1: Visual Assessment

- “Calibrate” eyes with calibration signs

- Calibration signs are near minimum retro

- Evaluate signs compared to calibration signs
Method 1: Visual Assessment

- Tie to minimum values with comparison panels
  - Panels are near desired retro
  - Clipped to sign - viewed from distance
  - Evaluate signs compared to panels
Method 1: Visual Assessment

- Tie to minimum values by using consistent parameters as used to develop the minimum levels
  - Inspector – older driver (60+)
  - SUV type vehicle
  - Cutoff headlamps (properly aimed)
Advantages / Disadvantages

- **Advantages:**
  - Low administrative and fiscal burden
  - Signs are viewed in their natural surroundings
  - Low level of sign replacement and sign waste.

- **Disadvantages:**
  - Subjective but research has shown that trained observers can reasonably and repeatedly detect signs with marginal retroreflectivity.
  - Exposure of conducting nighttime inspections
  - Paying overtime
MUTCD Methods

- Visual assessment
- Measured retroreflectivity
- Expected sign life
- Blanket replacement
- Control signs
- Future methods
- Combination of methods

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Method 2: Measure Sign Retro

- Use a portable instrument
- Receive proper training
- Have a protocol for consistency
- Compare readings to minimum values
Examples of Sign Retroreflectometers

Contact Devices:

Model 922
(Gamma Scientific)

Model GR3
(Delta)

Non-Contact Devices:

SMARTS Van

Experimental concept, but NOT yet available.
Handheld Devices as of April 2008

- **RoadVista Model 922**
  - Annular Device (one measurement on prisms)
  - Measurement Point: 1 inch in Diameter
  - Aperture reducer (for measuring narrow text)
  - GPS
  - Data storage (4,500 readings) & Download Software
  - Removable / Rechargeable Battery
  - Entrance Angle -4.0 degrees
  - Measures 2 observation angles at the same time (0.2 & 0.5)
  - Bar code reader
  - ASTM E1709 compliant
  - Extension Pole Kit is Available & Adjustable Entrance Angle Attachment
  - Built in USA

- **Delta RetroSign 4500 now replaced by the New Model GR3**
  - Point Device (two measurements on prisms 0 / 90 degrees)
  - Measurement Point: 1.2 inches
  - Aperture reducer (for measuring narrow text, .625 +/-)
  - GPS
  - Data storage (250,000 readings) & Download Software
  - Removable / Rechargeable Battery
  - Entrance Angle -4.0 degrees
  - 4500 Measures 1 observation angle (0.2)
  - GR3 Measures 3 observation angles at the same time (0.2 0.5 & 1)
  - RFID reader (field tag reading device)
  - ASTM E1709 compliant
  - Extension Pole Kit is Available
Information on Hand-Held Devices

- Delta Retrosign GR3
  - http://www.flinttrading.com

- RoadVista 922
  - http://www.roadvista.com

- Zehntner ZRS (Available in Europe)

- Mechatronic RC200 (Available in Europe)

- As of May 2008
Advantages / Disadvantages

- **Advantages:**
  - Provides the most direct means of monitoring the maintained retroreflectivity levels
  - Removes subjectivity

- **Disadvantages:**
  - Cost of instruments (approx $10,000 to $12,000)
  - Measuring all signs in a jurisdiction can be time consuming
  - Using retroreflectivity as the only indicator of whether or not a sign should be replaced may end up neglecting other attributes of the sign's overall appearance.
MUTCD Methods

- Visual assessment
- Measured retroreflectivity
- Expected sign life
- Blanket replacement
- Control signs
- Future methods
- Combination of methods

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Method 3: Expected Sign Life

- Find the life of the sheeting type in your area
- Replacement based on expected life for individual signs
Indicating Sign Age

- Stickers on front or back of sign to show when fabricated or installed

![Stickers on signs](image)
Determining Sign Life

- Build and use a weathering rack like the one shown
- Use AASHTO-NTPEP data
- Use warranty information from sheeting company
- Specify sign life
- Measure existing signs with know install date and compare to min level
- Use weathering data or nearby jurisdiction’s weathering data
Using Warranty Information

- Predicted sign age could be provided in a warranty by sheeting manufacturers.
- Typical warranties not typically based on minimum retroreflectivity levels.
- Agencies could develop specifications with warranties based on minimum retroreflectivity levels.
  - Example: Warranty Type III sheeting for 15 years in accordance to Table 2A-3 of the MUTCD
Advantages / Disadvantages

**Advantages:**
- This method requires that agencies track the installation date of their signs.
- Can use a date sticker, bar code, or computerized sign management system
- Agencies can develop or copy local service life levels

**Disadvantages:**
- It may be time consuming to inspect date stickers if the stickers are not easily viewable or identifiable on the sign.
- Another possible difficulty relates to marking signs that need to be replaced.
MUTCD Methods

- Visual assessment
- Measured retroreflectivity
- Expected sign life
- Blanket replacement
- Control signs
- Future methods
- Combination of methods

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Method 4: Blanket Replacement

- All signs in an area/corridor are replaced at the same time at specified intervals
- Specified intervals could be set based on expected sign life
- Some existing blanket sign replacement policies exist using 10-12 years for Beaded High-Intensity sheeting signs
Blanket Replacement

- Divide agency into areas/corridors or zones
- Relate number of areas to replacement cycle
- Replace all signs in an area/corridor each replacement cycle
  - 10 yr life, → 10 areas
  - Annual replacement in each area

Example
City of Tempe AZ Maintenance Zones
Advantages / Disadvantages

**Advantages:**
- The major benefit of using this method is that all signs are replaced; there is a low likelihood of a given sign being skipped over or not being replaced. This ensures that all replaced signs are visible and meet minimum retroreflectivity levels.

**Disadvantages:**
- The major drawback to this method is the potential amount of waste than can be generated if signs that are relatively new are removed during a normal replacement cycle.
MUTCD Methods

- Visual assessment
- Measured retroreflectivity
- Expected sign life
- Blanket replacement
- Control signs
- Future methods
- Combination of methods

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Method 5: Control Signs

- Sign life is estimated using a subset of signs representing an agency’s inventory.
  - Subset of signs is the “control signs”
- Control signs can be in-service signs or signs in a maintenance yard.
- Agency monitors control signs to estimate condition of all their signs.
- Periodically measure retroreflectivity of control signs.
Advantages / Disadvantages

Advantages:
- Not very labor intensive
- Low cost option

Disadvantages:
- Need to have an adequate sampling of signs
- Need to have signs selected from in-service signs or have a place in the designated area like a maintenance yard
MUTCD Methods

- Visual assessment
- Measured retroreflectivity
- Expected sign life
- Blanket replacement
- Control signs
- Future methods
- Combination of methods

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Method 6: Other Options

- Flexibility is provided for future advancements in technology and methods that have not been fully developed.
- Must be based on an engineering study.
MUTCD Methods

- Visual assessment
- Measured retroreflectivity
- Expected sign life
- Blanket replacement
- Control signs
- Future methods
- Combination of methods

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Combining Methods

- Use one or more of the methods together
  - Support and reinforce each other
  - Use one as quality control of another

- Possibilities
  - Visual inspection to identify signs to be measured
  - Measured retro of control signs
Summary: Methods Allowed

- Visual Nighttime Inspection
  - Calibration Signs
  - Comparison Panels
  - Consistent Parameters
- Measured Sign Retro
- Expected Sign Life
- Blanket Replacement
- Control Signs
- Future Method Based On Engr. Study
- Combination Of Any
What Should I Do Next?

- Select maintenance method(s)
- Budget to implement method
- Train inspectors (ask LTAP for slides)
- Implement maintenance method(s)
- **Decide on sheeting types**
  - Consider initial and life cycle costs
- Budget for future sign replacement
Decide on Sheeting Types

- Engineering grade (EG)
  - ASTM Type I
- Super engineer grade (SEG)
  - ASTM Type II
- High intensity (HI)
  - ASTM Type III
- Microprismatic (MP)
  - ASTM Types III, IV, VII, VIII, IX, X
- Delineators
  - ASTM Type V
- Roll-up
  - ASTM Type VI
New MUTCD Table 2A.3
Minimum Maintained Retroreflectivity Levels

<table>
<thead>
<tr>
<th>Sign Color</th>
<th>Sheetng Type (ASTM D4956-04)</th>
<th>Beaded Sheeting</th>
<th>Prismatic Sheeting</th>
<th>Additional Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
<td>III, IV, VI, VII, VIII, IX, X</td>
</tr>
<tr>
<td>White on Green</td>
<td>W* G ≥ 7</td>
<td>W* G ≥ 15</td>
<td>W* G ≥ 25</td>
<td>W ≥ 250; G ≥ 25</td>
</tr>
<tr>
<td></td>
<td>W* G ≥ 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black on Yellow or</td>
<td>Y*; O*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black on Orange</td>
<td>W ≥ 75; O ≥ 75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Black on White</td>
<td>W ≥ 35; R ≥ 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>White on Red</td>
<td>W ≥ 50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

① The minimum maintained retroreflectivity levels shown in this table are in units of cd/lx/m² measured at an observation angle of 0.2° and an entrance angle of -4.0°.
② For text and fine symbol signs measuring at least 1200 mm (48 in) and for all sizes of bold symbol signs.
③ For text and fine symbol signs measuring less than 1200 mm (48 in).
④ Minimum Sign Contrast Ratio ≥ 3:1 (white retroreflectivity ÷ red retroreflectivity).
* This sheeting type should not be used for this color for this application.
Yellow - ASTM Specification (new matl, 0.2, -4.0)

- Required Minimum Maintained Levels
  - ASTM Type
    - I
    - II
    - III
  - cd/lx/m²
    - 0
    - 50
    - 100
    - 150
    - 200
    - 250
    - 300
    - 350
    - 400
  - Average
  - Super EG
  - High Inten
  - Prismatic Average

U.S. Department of Transportation
Federal Highway Administration
Generalized Life of Yellow Sheeting
(no data)

Years

New Sheeting Retroreflectivity Spec Value

- Average of Some Prismatics
- High Intensity
- Super EG

Required Minimum Maintained Levels

Years
What are reasonable costs you can expect for these materials:
Assume per sq. ft
- Engineering Grade ____
- Super Engineer Grade ____
- High Intensity Beaded ____
- High Intensity Prismatic ____
- Other Prismatic (Avery, NCI, or DG3) ____
Life Costs of Warning Signs with Different Sheetings

- Warning sign
  - Engineering Grade = _____ ÷ 7 = _____$/yr
  - Super Engineer Grade = _____ ÷ 10 = _____$/yr
  - High Intensity Beaded = _____ ÷ 12 = _____$/yr
  - High Intensity Prismatic = _____ ÷ 12 = _____$/yr
  - Other Prismatic = _____ ÷ 16 = _____$/yr

Now what if you have 2000 warning signs?
More Information

- ATSSA  www.retroreflectivity.net
  - Primer on retroreflectivity
  - Common questions
- FHWA  fhwa.dot.gov/retro
  - Summary Brochure
  - Final Rule
  - Power Point Presentations
  - Newsletter Articles
  - Frequently Asked Questions
Traffic signs provide important information to drivers at all times, both day and night. To be effective, their visibility must be maintained. The 2003 Manual on Uniform Traffic Control Devices (MUTCD) addresses sign visibility in several places, including Sections 1A.01, 1A.04, 1A.05, 1A.06, 2A.08, and 2A.22. These sections address factors such as uniformity, design, placement, operation, and maintenance. Previously, the MUTCD did not specify minimum retroreflectivity levels.

The second revision of the 2003 MUTCD introduces new language establishing minimum retroreflectivity levels that must be maintained for traffic signs. Agencies have until January 2012, to establish and implement a sign assessment or management method to maintain minimum levels of sign retroreflectivity. The compliance date for regulatory, warning, and general instruction guide signs is January 2015. For overhead guide signs and street name signs, the compliance date is January 2019. The new MUTCD language is shown on page 2 and 3 of this document.

The new standard in Section 2A.08 requires that agencies maintain traffic signs to a minimum level of retroreflectivity outlined in Table 2A.3 of the MUTCD. The Federal Highway Administration (FHWA) believes that this proposed change will promote safety while providing sufficient flexibility for agencies to choose a maintenance method that best matches their specific conditions.

Including Table 2A.3 in the MUTCD does not imply that an agency must measure the retroreflectivity of every sign. Rather, the new MUTCD language describes the methods that agencies can use to maintain traffic sign retroreflectivity at or above the minimum levels. Agencies can choose from these methods or combine them. Agencies are allowed to develop other appropriate methods based on engineering studies. However, agencies should adopt a consistent method that produces results that correspond to the values in Table 2A.3. The new MUTCD language recognizes that there may be some individual signs that do not meet the minimum retroreflectivity level at a particular position time. As long as the agency with jurisdiction is maintaining signs in accordance with Section 2A.08 of the MUTCD, the agency will be considered to be in compliance. This document describes methods that can be used to maintain sign retroreflectivity at or above the MUTCD’s minimum maintained retroreflectivity levels.

RETOREFLECTIVITY MAINTENANCE

The MUTCD describes two basic types of methods that agencies can use to maintain sign retroreflectivity at or above the MUTCD minimum maintained retroreflectivity levels — assessment methods and management methods. The FHWA has identified an endorsed assessment and management methods for maintaining sign retroreflectivity in accordance with Section 2A.08. These methods are described on page 4. A full report on these methods can be found at www.fhwa.dot.gov/retro.
### FHWA Retroreflective Sheeting Identification Guide – September 2005

**Notes:** ASTM Types are shown as stated by the manufacturers using ASTM D4956-04 “type” designations. Agencies should verify that the sheeting they use complies with their specifications or ASTM D4956. FHWA does not endorse or approve any material nor does it determine type category(s) for materials. This side of the Sheeting ID Guide is for rigid surfaces only. The other side is for flexible surfaces and non-signing applications.

**Retrorreflective Sheeting Materials for Rigid Sign Surfaces Made with Glass Beads**

<table>
<thead>
<tr>
<th>ASTM Type</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>III</th>
<th>III</th>
<th>III</th>
<th>III</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>See note A</td>
<td>Avery Dennison®</td>
<td>Nippon Carbide</td>
<td>3M™</td>
<td>ATSM, Inc.</td>
<td>Avery Dennison®</td>
<td>Kiwalite®</td>
<td>LG Lite</td>
</tr>
<tr>
<td>Brand Name</td>
<td>Engineer Grade</td>
<td>Super Engineer Grade</td>
<td>Super Engineer Grade</td>
<td>High Intensity</td>
<td>High Intensity</td>
<td>High Intensity</td>
<td>High Intensity</td>
<td>High Intensity</td>
</tr>
<tr>
<td>Series Number</td>
<td>Several</td>
<td>T-2000</td>
<td>15000</td>
<td>17000</td>
<td>18000</td>
<td>2800</td>
<td>3800</td>
<td>ASTM HI</td>
</tr>
</tbody>
</table>

**NOTES:**

A – All the manufacturers listed on the other side of this guide (except Reflexite) provide Engineer Grade sheeting. Engineer Grade sheeting is uniform without any patterns or identifying marks. Visually, it is indistinguishable from lower quality grades (i.e., utility and commercial grades).

B – These materials can be classified as different ASTM Types.

C – These materials are visually indistinguishable from one another.

D – The arrow or “water mark” on this product is no longer included with new productions.

### Retroreflective Sheeting Materials for Rigid Sign Surfaces Made with Prisms

<table>
<thead>
<tr>
<th>ASTM Type</th>
<th>III, IV</th>
<th>III, IV, X</th>
<th>VII, VIII, X</th>
<th>VIII</th>
<th>IV, VII</th>
<th>IX</th>
<th>IX</th>
<th>X</th>
<th>Unassigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Avery Dennison®</td>
<td>3M™</td>
<td>3M™</td>
<td>Avery Dennison®</td>
<td>Nippon Carbide</td>
<td>3M™</td>
<td>Avery Dennison®</td>
<td>Nippon Carbide</td>
<td>3M™</td>
</tr>
<tr>
<td>Brand Name</td>
<td>High Intensity Prismatic</td>
<td>High Intensity Prismatic</td>
<td>Diamond Grade™ LDP</td>
<td>MVP Prismatic</td>
<td>Crystal Grade</td>
<td>Diamond Grade™ VIP</td>
<td>Omni-View™</td>
<td>Crystal Grade</td>
<td>Diamond Grade™ DG3</td>
</tr>
<tr>
<td>Series Number</td>
<td>T-6500</td>
<td>3930</td>
<td>3970</td>
<td>T-7500</td>
<td>94000 (IV)</td>
<td>92000 (VIII)</td>
<td>3990</td>
<td>T-9500</td>
<td>93000</td>
</tr>
</tbody>
</table>

**NOTES:**

B – These materials can be classified as different ASTM Types.

C – These materials are visually indistinguishable from one another.
Safer Sign Supports: Are Your Breakaway Yet?

New Sign Reflectivity Requirements

Retroreflectivity Requirements
Recent FHWA Related Reports

Low-Cost Treatments for Horizontal Curve Safety

Good Practices: Incorporating Safety into Resurfacing and Restoration Projects


U.S. Department of Transportation
Federal Highway Administration
For Further Information

- LTAP contact
- State DOT
- FHWA Division Office
What Should My Agency Do Now?

Act casual, say nothing and hope no one notices, or be proactive and help drivers?