Conducting Visual Nighttime Inspections

Sign Retroreflectivity Requirements in the MUTCD

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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
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Compliance Dates

• January 2012 – All agencies have to establish a sign maintenance program that can regularly address the new minimum sign retroreflectivity requirements.

• January 2015 – By this date, all agencies must comply with the new retroreflectivity requirements for most of their traffic signs they have installed, including all red or white “regulatory” signs (such as STOP signs and Speed limit signs), yellow “warning” signs, and green/white “guide” signs.

• January 2018 – By this date, all agencies must comply with the new retroreflectivity requirements for overhead guide signs and all street name signs.

Why is retroreflectivity important?

Liability

Reasons for Highest Amounts Claimed

<table>
<thead>
<tr>
<th>Reason</th>
<th>Amount in Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic signal malfunction/defective</td>
<td>$6.40</td>
</tr>
<tr>
<td>Shoulder dropped</td>
<td>$6.70</td>
</tr>
<tr>
<td>Inadequate traffic control device in work zone</td>
<td>$6.90</td>
</tr>
<tr>
<td>Accident involving V/C vehicle</td>
<td>$7.00</td>
</tr>
<tr>
<td>Accident due to pavement</td>
<td>$7.10</td>
</tr>
<tr>
<td>Lack of guardrail</td>
<td>$12.90</td>
</tr>
<tr>
<td>Improper drainage</td>
<td>$14.10</td>
</tr>
<tr>
<td>Inadequate/Improper signage</td>
<td>$21.60</td>
</tr>
</tbody>
</table>
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Night Travel and Crashes

What signs need replaced?

Can we decide to replace signs based on daytime inspections?

Retroreflectivity

- What is it?
  - A sign’s ability to reflect light back to the driver
- Why use it?
  - Increases sign visibility at night
  - Important since nighttime fatal crashes occur approximately three times as often as daytime fatal crashes
  - Older driving population is increasing
- Why maintain it?
  - Retroreflectivity degrades over time and maintaining signs will save lives
  - Public agencies are responsible for maintaining highways and streets and required to use retroreflective materials
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Nighttime Driving

Daytime
Many cues available
Driver task relatively easy

Nighttime
Few cues remain
Task more difficult

Retroreflectivity provides nighttime guidance

Reflection

Source or Diffuse Reflection

Retroreflection

Internal Max Reflection ( specular )
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Retroreflective Elements

- 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

Yellow - ASTM Specification (new matl, 0.2, 4.0)

- Required Minimum Maintenance
- Levels
- ASTM Type
- Average
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Generalized Life of Yellow Sheeting

Years

<table>
<thead>
<tr>
<th>New Sheeting Retroreflectivity Spec Value</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super EG</td>
<td>$164</td>
</tr>
<tr>
<td>High Intensity</td>
<td>$168</td>
</tr>
<tr>
<td>Prismatic</td>
<td>$192</td>
</tr>
</tbody>
</table>

EXAMPLE of Sign Costs

<table>
<thead>
<tr>
<th>Sheetng</th>
<th>Cost to Replace*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Grade</td>
<td>$160</td>
</tr>
<tr>
<td>Super EG</td>
<td>$164</td>
</tr>
<tr>
<td>High Intensity</td>
<td>$168</td>
</tr>
<tr>
<td>Prismatic</td>
<td>$192</td>
</tr>
</tbody>
</table>

*Generalized numbers based on information from sign test racks for substrate, labor and sheeting

EXAMPLE of Life Cycle Costs

<table>
<thead>
<tr>
<th>Sheetng</th>
<th>Cost to Replace*</th>
<th>Useful Life</th>
<th>Cost Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Grade</td>
<td>$160</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>Super EG</td>
<td>$164</td>
<td>12</td>
<td>$13.7</td>
</tr>
<tr>
<td>High Intensity</td>
<td>$168</td>
<td>12</td>
<td>$14</td>
</tr>
<tr>
<td>Prismatic</td>
<td>$192</td>
<td>30</td>
<td>$6.4</td>
</tr>
</tbody>
</table>

*Generalized numbers based on information from sign test racks for substrate, labor and sheeting

Even more savings when you factor in potential cost of traffic hazard!
Sign Maintenance Methods

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

Assessment Methods
- Visual Inspection
- Measured Sign Retroreflectivity

Management Methods
- Expected Sign Life
- Blanket Replacement
- Control Signs

Assessment Methods
- Visual Inspection Method
  - Comparison Panel Procedure
  - Calibrated Sign Procedure
  - Consistent Parameter Procedure
- Measure Sign Retroreflectivity

Visual Inspection Method
Comparison Panel Procedure
Comparison Panels

- Comparison panels must have a retroreflectivity level at least that designated in the MUTCD.

Source of Comparison Panels

- With a retroreflectometer, an agency can find in-service signs near the minimum levels. These signs can be removed from service and cut into smaller pieces.
- An agency can also look through their scrap yard.
- Avery-Dennison has a comparison panel kit for sale.

Assessment Methods

- Visual Inspection Method
  - Comparison Panel Procedure
  - Calibrated Sign Procedure
  - Consistent Parameter Procedure
- Measured Sign Retroreflectivity
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Visual Inspection Method
Calibrated Signs Procedure

Calibrated Signs Overview
• Before leaving the maintenance yard, the inspectors visually inspects a set of representative signs in an effort to calibrate their eyes before starting the nighttime inspections
• Typical viewing distance
• Use low beams and make sure lights are calibrated prior to departure
• The inspection occurs at highway speeds
• During the visual inspection, look for signs less bright than the calibration signs
• Mark these signs for replacement
• May include a route that allows inspector to review calibration signs during inspection

Source of Calibration Signs
• With a retroreflectometer, an agency can find in-service signs near the minimum levels. These signs can be removed from service and stored until nighttime sign inspections commence.
• An agency can also look through their scrap yard for representative signs.
• Avery-Dennison sells calibration signs
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Assessment Methods

- Visual Inspection Method
  - Comparison Panel Procedure
  - Calibrated Sign Procedure
  - Consistent Parameter Procedure
- Measured Sign Retroreflectivity

Visual Nighttime Inspection Method
Consistent Parameter Procedure

Consistent Parameter Overview

- With this method, a SUV or truck has to be used with specific headlamps and the inspector needs to be at least 60 years old.
- The inspection occurs at highway speeds.
- No calibration signs or comparison panels are needed.
- This method simulates the conditions of the research which FHWA used as a foundation for the minimum retroreflectivity levels.
Assessment Methods

• Visual Inspection Method
  – Comparison Panel Procedure
  – Calibrated Sign Procedure
  – Consistent Parameter Procedure

• Measured Sign Retroreflectivity

How to use a Retroreflectometer

Methods of Inspection

• Measured Sign Retroreflectivity Method
  – Sign retroreflectivity is measured using a retroreflectometer
  – Signs with retroreflectivity below the minimum levels should be replaced
  – This requires you to measure all of your signs on a specific interval (once every year or every other year)
Advantages / Disadvantages

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

- **Disadvantages:**
  - Cost of instruments (approx $12,000 to $15,000)
  - 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.

### New MUTCD Table 2A.3
**Minimum Maintained Retroreflectivity Levels**

<table>
<thead>
<tr>
<th>Color</th>
<th>Additional Criteria</th>
<th>Beaded Sheeting</th>
<th>Prismatic Sheeting</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>White on Green</em></td>
<td></td>
<td><em>W</em>; <em>G</em> ≥ 7</td>
<td><em>W</em>; <em>G</em> ≥ 15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>W</em>; <em>G</em> ≥ 25</td>
</tr>
<tr>
<td><em>White on Red</em></td>
<td>Overhead</td>
<td><em>W</em> ≥ 250</td>
<td><em>G</em> ≥ 250</td>
</tr>
<tr>
<td><em>Black on Yellow</em></td>
<td></td>
<td><em>Y</em> ≥ 50</td>
<td><em>O</em> ≥ 50 (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>Y</em> ≥ 75; <em>O</em> ≥ 75 (3)</td>
</tr>
<tr>
<td><em>Black on White</em></td>
<td></td>
<td><em>W</em> ≥ 35; <em>R</em> ≥ 7(4)</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°.
2. For text and fine symbol signs measuring at least 1200 mm (48 inches) and for all sizes of bold symbol signs.
3. For text and fine symbol signs measuring less than 1200 mm (48 inches).

* This sheeting type should not be used for this color for this application.

### Table 2A.3 Warning Signs

**Bold Symbol Signs**

- W1-1, -2 – Turn and Curve
- W1-3, -4 – Reverse Turn and Curve
- W1-5, -6 – Winding Road
- W1-7, -8 – Large Arrow
- W1-9, -10 – Intersection in Curve
- W1-11 – 270 Degree Loop
- W2-1 – Cross Road
- W2-2, -3 – Side Road
- W2-4, -5 – T and Y Intersection
- W2-6 – Circular Intersection
- W2-7 – Warning
- W2-8 – Divided Highway
- W2-9 – Highway End
- W2-10 – Added Lane
- W2-11 – Merge
- W2-12 – Lane Ends
- W2-13 – Exit Ramp
- W2-14 – Entering Ramp
- W2-15 – Exit Ramp
- W2-16 – Warning
- W2-17 – Divided Highway
- W2-18 – Warning
- W2-19 – Divided Highway
- W2-20 – Divided Highway
- W2-21 – Divided Highway
- W2-22 – Warning
- W2-23 – Divided Highway
- W2-24 – Warning
- W2-25 – Divided Highway
- W2-26 – Warning
- W2-27 – Divided Highway
- W2-28 – Warning
- W2-29 – Divided Highway
- W2-30 – Warning
- W2-31 – Divided Highway
- W2-32 – Warning
- W2-33 – Divided Highway
- W2-34 – Warning
- W2-35 – Divided Highway
- W2-36 – Warning
- W2-37 – Divided Highway
- W2-38 – Warning
- W2-39 – Divided Highway
- W2-40 – Warning
- W2-41 – Divided Highway
- W2-42 – Warning
- W2-43 – Divided Highway
- W2-44 – Warning
- W2-45 – Divided Highway
- W2-46 – Warning
- W2-47 – Divided Highway
- W2-48 – Warning
- W2-49 – Divided Highway
- W2-50 – Warning
- W2-51 – Divided Highway
- W2-52 – Warning
- W2-53 – Divided Highway
- W2-54 – Warning
- W2-55 – Divided Highway
- W2-56 – Warning
- W2-57 – Divided Highway
- W2-58 – Warning
- W2-59 – Divided Highway
- W2-60 – Warning
- W2-61 – Divided Highway
- W2-62 – Warning
- W2-63 – Divided Highway
- W2-64 – Warning
- W2-65 – Divided Highway
- W2-66 – Warning
- W2-67 – Divided Highway
- W2-68 – Warning
- W2-69 – Divided Highway
- W2-70 – Warning
- W2-71 – Divided Highway
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- W2-73 – Divided Highway
- W2-74 – Warning
- W2-75 – Divided Highway
- W2-76 – Warning
- W2-77 – Divided Highway
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- W2-79 – Divided Highway
- W2-80 – Warning
- W2-81 – Divided Highway
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- W2-83 – Divided Highway
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- W2-87 – Divided Highway
- W2-88 – Warning
- W2-89 – Divided Highway
- W2-90 – Warning
- W2-91 – Divided Highway
- W2-92 – Warning
- W2-93 – Divided Highway
- W2-94 – Warning
- W2-95 – Divided Highway
- W2-96 – Warning
- W2-97 – Divided Highway
- W2-98 – Warning
- W2-99 – Divided Highway
- W2-100 – Warning
- W2-101 – Divided Highway
- W2-102 – Warning
- W2-103 – Divided Highway
- W2-104 – Warning
- W2-105 – Divided Highway
- W2-106 – Warning
- W2-107 – Divided Highway
- W2-108 – Warning
- W2-109 – Divided Highway
- W2-110 – Warning

**Fine Symbol Signs – Symbol signs not listed as Bold Symbol Signs.**
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Table 2A.3 Special Cases

W3-1 – Stop Ahead: Red retroreflectivity ≥ 7
W3-2 – Yield Ahead: Red retroreflectivity ≥ 7, White retroreflectivity ≥ 35
W3-3 – Signal Ahead: Red retroreflectivity ≥ 7, Green retroreflectivity ≥ 7
W3-5 – Speed Reduction: White retroreflectivity ≥ 50

For non-diamond shaped signs such W14-3 (No Passing Zone), W4-4p (Cross Traffic Does Not Stop), or W13-1, -2, -3, -5 (Speed Advisory Plaques), use largest sign dimension to determine proper minimum retroreflectivity level.

Management Methods

• Expected Sign Life
• Blanket Replacement
• Control Signs

Methods of Inspection

• Expected Sign Life Method
  – Date is labeled or recorded when a sign is installed
  – Age of the sign is compared to the expected sign life
  – Expected sign life is based on the knowledge of how old signs are in the geographic area compared to minimum levels
  – When signs reach their life expectancy, the signs are replaced
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Methods of Inspection

• Blanket Replacement Method
  – All signs in an area/corridor or of a given type are replaced at specified intervals
  – Eliminates the need to assess retroreflectivity or track the life of individual signs
  – This method is based on the expected sign life

Blanket Replacement Example

Methods of Inspection

• Control Signs Method
  – Replacement of signs in the field is based on the performance of a sample set of signs
  – Control signs might be a small sample located in a maintenance yard or a selection of signs in the field
  – Control signs are monitored to determine the end of retroreflective life
  – All signs represented by a specific set of control signs should be replaced before the retroreflectivity levels of the control signs reach the minimum retroreflectivity levels
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Suggestions
- Electronic, GPS-based inventory
- Backup inventory
- Redundant test decks
- Track inspections, history, events
- Combine methods
- Quality control

Implementation Using Combined Methods
- Methodology similar to what KYTC will be using
  - Calibration signs
  - Comparison panels
- Inventory is highly recommended no matter what method you choose
  - Paper/Electronic
  - Milepoint/GPS-based

Steps to Compliance
1. Collect sign inventory and daytime inspection
2. Use inventory to conduct a nighttime visual inspection for retro-reflectivity
3. Replace any ineffective signs
4. Track replacement
5. Use test deck to determine when to replace tracked signs
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Step 1: Collect Inventory of Signs

- Collect data using GPS receiver connected to a laptop running sign inventory software.
- During inventory, mark signs that are in need of repair: damaged, installed improperly, wrong sign, improper placement, etc.

(screenshot from www.signprox.net)

Step 1: Conduct Daytime Inspection

- Inventory assembly’s location (GPS and milepoint).
- Collect sign arrangement.
- Indicate any damage (no need to assess retro if it must be replaced).

(screenshot from www.signprox.net)
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What is Damaged?
- Is the sign effectively delivering the message?
- Use best judgment
- Examples include: bent, shot, graffiti, washed out, illegible, etc.
- Be sure to note if the sign can be repaired: positioned improperly, needs cleaning, obstructed

Step 2: Conduct Visual Nighttime Inspection
- Avery’s MRS Kit / Build your own
  - Calibration signs
  - Comparison panels
- Follow checklist
- Use inventory software with GPS
  OR
- Print out inventory form
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Calibration Signs

Comparison Panels

Visual Inspections List
- Use a two person crew
- Must have a model year 2000 or newer SUV, pick-up, or similar vehicle
- Make sure vehicle lights have been calibrated
- Inspector needs to be well rested
- Have routes selected
- Be able to flag signs that fail retro-reflectivity test or otherwise need replacing
Step 3: Replace damaged or non-compliant signs

- Create a list of signs to replace or use inventory software
- Consider useful life when choosing a sheeting type to replace with
- Update damage/retro-reflectivity fields as signs are replace

Step 4: Track Replacements

- Use a coded sticker system to identify and track signs as they are replaced
- Maintain this code in the existing inventory
- Track the date installed and manufactured
- QR codes, bar codes or an ID

Step 5: Test Decks

- Eventually all signs will be coded and their useful life can be tracked using warranty and test decks
- Replace similar signs as useful life is reached or as test deck signs begin to fail
- Test deck recommendation: mount signs at 45 degree angle, facing south
Control Deck

Stamping Ground – Case Study

- Field work completed in one day
- Collected inventory
- Assessed retroreflectivity using
  - Retro gun
  - Comparison panels
- Documented as UK student chapter ITE project
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MUTCD Proposal

- On August 31, a Notice of Proposed Amendments was published in the Federal Register, proposing to revise most of the target compliance dates for upgrading existing traffic control devices in the field that do not meet the current MUTCD standards. The deadline for comments to the docket is October 31, 2011. The Federal Register notice, which provides detailed discussion of the FHWA's proposal, can be viewed online.

- After reading the Federal Register notice, to submit a comment to the docket, please go to www.regulations.gov.

Proposed Changes

http://mutcd.fhwa.dot.gov/knowledge/09mutcdproposedrev/compliance_dates/
Proposed Changes

• Just because the compliance dates are proposed to be eliminated, doesn’t mean you don’t need to maintain your signs
• You must still have a defendable plan in the event of lawsuit
• You need to have a plan in place to maintain regulatory and warning signs 2 years from the effective date which will be some time after the comment period closed (October 31st, 2011)
• There is no compliance date for this, but be sure your plan is defendable.

Proposed Changes

• It is proposed to remove the compliance dates for all signs and only require a plan to maintain regulatory and warning signs
• This does not mean that other signs (guide signs for example) are not required
• New signs must meet retro-reflectivity levels.

If Compliance Dates are Eliminated…

• Unless a particular device is no longer serviceable, non-compliant devices on existing highways and bikeways shall be brought into compliance with the current edition of the National MUTCD as part of the systematic upgrading of substandard traffic control devices (and installation of new required traffic control devices)
• Page I-3, paragraph 22
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Resources

  - FHWA-HRT-08-026
- FHWA  www.fhwa.dot.gov/retro
- ATSSA  www.retroreflectivity.net
- www.minimumreflectivity.org

Portions of this presentation provided by:

- Traffic Management through Signal, Signs and Markings and Risk Management/Tort Liability
  - Ken Agent, Kentucky Transportation Center, The University of Kentucky
- Conducting Sign Retroreflectivity Inspections
  - Dr. Paul Carlson and Dr. Gene Hawkins, Texas Transportation Institute, The Texas A&M University System
- Sign Retroreflectivity Course
  - Eric Green and Martha Horseman, Kentucky Transportation Center, The University of Kentucky

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