PRACTICES TO MANAGE TRAFFIC SIGN RETROREFLECTIVITY

NCHRP Synthesis Report 431

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Presentation Outline

• Overview of new MUTCD requirements on minimum sign retroreflectivity

• Summary of NCHRP Synthesis 431
Final Rule – Sign Retro

• Published on Dec 21, 2007
  ▪ Vol 72, No. 245

• Revision #2 of the 2003 Edition of the MUTCD

• Effective Jan 22, 2008
New MUTCD Language

• “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.
MUTCD Methods

• Visual assessment
• Measured retroreflectivity
• Expected sign life
• Blanket replacement
• Control signs
• Future methods
• Combination of methods
<table>
<thead>
<tr>
<th>Sign Color</th>
<th>Sheet Type (ASTM D4956-04)</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></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>W*</td>
<td></td>
<td>W*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G ≥ 7</td>
<td></td>
<td>G ≥ 15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>W*</td>
<td></td>
<td>G ≥ 25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>W ≥ 250; G ≥ 25</td>
<td></td>
<td></td>
<td>Overhead</td>
</tr>
<tr>
<td></td>
<td>W*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G ≥ 7</td>
<td></td>
<td></td>
<td>Ground-mounted</td>
</tr>
<tr>
<td>Black on Yellow or Black on Orange</td>
<td>Y*, O*</td>
<td></td>
<td>Y ≥ 50; O ≥ 50</td>
<td>②</td>
</tr>
<tr>
<td></td>
<td>Y*</td>
<td></td>
<td>Y ≥ 75; O ≥ 75</td>
<td>③</td>
</tr>
<tr>
<td>White on Red</td>
<td>W ≥ 35; R ≥ 7</td>
<td></td>
<td></td>
<td>④</td>
</tr>
<tr>
<td>Black on White</td>
<td>W ≥ 50</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 shall not be used for this color for this application.
Current Compliance Dates

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

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

- Replace identified street name & overhead guide signs
  - January, 2018

Subject to change - see August 31, 2011 NPA
http://mutcd.fhwa.dot.gov/
Proposed Changes

- Establish and implement method(s) for regulatory and warning signs
  - January 2012 summer 2014 ?

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

- Replace identified street name & overhead guide signs
  - January, 2018
NCHRP Synthesis 431

- Document the state-of-the-practice
- Provide examples of effective strategies
- Show how other agencies can remain in compliance
- Determine needs and areas of future research
Study Approach

• Identified agencies already doing good job
• Asked 14 main questions
• Major items of interest:
  ▪ Agency size and background information
  ▪ Selected method execution and benefits
  ▪ Challenges and issues
Survey Participants

- Collected information from 49 different agencies and organizations
- Included 9 cities, 15 counties, 16 DOTs, and 9 others
- Diverse sample: geography, climate, and demographics
- Telephone surveys typically lasted 30 minutes
Survey Participants
## Participant Method Selection

<table>
<thead>
<tr>
<th>MUTCD Methods</th>
<th>Primary Sign Replacement Method</th>
<th>Secondary or Support Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nighttime Inspection</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Measured Retro.</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Expected Sign Life</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>Blanket Replacement</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Control Signs</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

Note: Table only includes agencies that operate and maintain roadways that are open to the public.
Case Studies

• Town of Clifton Park, New York
• St. Louis County, Minnesota
• City of Phoenix, Arizona
• Missouri Department of Transportation
Visual Nighttime Inspection Tips

- Many agencies are not using one of the 3 techniques of visual nighttime inspection
- Provide training and procedural guidelines
- Document inspections and sign replacements
- Monitor other maintenance issues while conducting nighttime inspections
MUTCD maintenance methods

Guidance:

Except for those signs specifically identified in Paragraph 6, one or more of the following assessment or management methods should be used to maintain sign retroreflectivity:

A. Visual Nighttime Inspection—The retroreflectivity of an existing sign is assessed by a trained sign inspector conducting a visual inspection from a moving vehicle during nighttime conditions. Signs that are visually identified by the inspector to have retroreflectivity below the minimum levels should be replaced.

B. Measured Sign Retroreflectivity—Sign retroreflectivity is measured using a retroreflectometer. Signs with retroreflectivity below the minimum levels should be replaced.

C. Expected Sign Life—When signs are installed, the installation date is labeled or recorded so that the age of a sign is known. The age of the sign is compared to the expected sign life. The expected sign life is based on the experience of sign retroreflectivity degradation in a geographic area compared to the minimum levels. Signs older than the expected life should be replaced.

D. Blanket Replacement—All signs in an area/corridor, or of a given type, should be replaced at specified intervals. This eliminates the need to assess retroreflectivity or track the life of individual signs. The replacement interval is based on the expected sign life, compared to the minimum levels, for the shortest-life material used on the affected signs.
MUTCD maintenance methods

E. Control Signs—Replacement of signs in the field is based on the performance of a sample of control signs. The control signs might be a small sample located in a maintenance yard or a sample of signs in the field. The control signs are monitored to determine the end of retroreflective life for the associated signs. All field signs represented by the control sample should be replaced before the retroreflectivity levels of the control sample reach the minimum levels.

E. Other Methods—Other methods developed based on engineering studies can be used.

Support:

Additional information about these methods is contained in the 2007 Edition of FHWA’s “Maintaining Traffic Sign Retroreflectivity” (see Section 1A.11).

Option:

Highway agencies may exclude the following signs from the retroreflectivity maintenance guidelines described in this Section:

A. Parking, Standing, and Stopping signs (R7 and R8 series)
B. Walking/Hitchhiking/Crossing signs (R9 series, R10-1 through R10-4b)
C. Acknowledgment signs
D. All signs with blue or brown backgrounds
E. Bikeway signs that are intended for exclusive use by bicyclists or pedestrians
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.03, 1A.04, 1A.05, 2A.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 ground-mounted guide signs is January 2013. For overhead guide signs and street name signs, the compliance date is January 2018. The new MUTCD language is shown on page 3 of this document.
Measured Retroreflectivity

- Hand-held devices becoming more common
  - Measurement time is major burden
- Mobile devices are now available
  - see: www.AMACglobal.com
- Hand-held devices – good for small agencies
- Mobile technology – good for large sign populations and overhead signs
- Minimizes subjectivity but does not eliminate tort
Expected Sign Life

• Service life is typically longer than warranty period
• New technologies available
• Little administrative requirements needed
• May be difficult to transition into
## Black on White Regulatory Signs Comparison

<table>
<thead>
<tr>
<th>ASTM Retroreflective Sheeting Type*</th>
<th>ASTM New Sheeting $R_A$ Values*</th>
<th>Typical Manufacturers’ Warranty $R_A$ Values</th>
<th>MUTCD Minimum $R_A$ Level</th>
<th>Difference in Warranty and Minimum $R_A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>70</td>
<td>56</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>II</td>
<td>140</td>
<td>112</td>
<td>50</td>
<td>62</td>
</tr>
<tr>
<td>III</td>
<td>250</td>
<td>200</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>IV</td>
<td>360</td>
<td>288</td>
<td>50</td>
<td>238</td>
</tr>
<tr>
<td>VIII</td>
<td>700</td>
<td>560</td>
<td>50</td>
<td>510</td>
</tr>
<tr>
<td>IX</td>
<td>380</td>
<td>304</td>
<td>50</td>
<td>254</td>
</tr>
<tr>
<td>XI</td>
<td>580</td>
<td>464</td>
<td>50</td>
<td>414</td>
</tr>
</tbody>
</table>
Weathering Racks

The graph shows the variation of $R_\lambda$ (cd/lx/m²) with simulated age (years) for different types of weathering racks. The types are denoted as follows:

- Type VIII
- Type IX
- Type IV
- Type III (x)
- Type III (y)
- Type III (z)
- Type II

The minimum value for small black on yellow signs is also indicated on the graph.
Myths and Misinformation

• On-the-job experience is a substitute for training for nighttime inspection.
• Engineering grade material is not allowed now.
• A computer inventory is required.
• You must have 60 year old for nighttime inspection.
• Warranty period provides a good estimate for service life.
Discussions and Questions

Sign Management Programs Across the Nation

Steve Norkus
Professional Pavement Products, Inc.
Retroreflectometer Product Manager
PPP Survey Considerations

* Data collected between January 2011 – April 2012 as part of various Professional Pavement Products’ sales and marketing efforts
* All answers are self-reported and unconfirmed
* Efforts were made to reduce duplicate agency reports
498 Agency Respondents
<table>
<thead>
<tr>
<th>Signs in Jurisdiction</th>
<th>% Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 2,000</td>
<td>5.42%</td>
</tr>
<tr>
<td>2,000 - 10,000</td>
<td>25.10%</td>
</tr>
<tr>
<td>10,000 - 25,000</td>
<td>14.26%</td>
</tr>
<tr>
<td>25,000 - 50,000</td>
<td>12.05%</td>
</tr>
<tr>
<td>50,000 +</td>
<td>43.17%</td>
</tr>
</tbody>
</table>
GIS Software Adoption

- Under 2,000
- 50,000 +
- 25,000 - 50,000
- 2,000 - 10,000
- 10,000 - 25,000

Inventoried and managed via GIS

- Under 2,000
- 50,000 +
- 25,000 - 50,000
- 2,000 - 10,000
- 10,000 - 25,000

Inventoried manually

- Under 2,000
- 50,000 +
- 25,000 - 50,000
- 2,000 - 10,000
- 10,000 - 25,000

Neither

- Under 2,000
- 50,000 +
- 25,000 - 50,000
- 2,000 - 10,000
- 10,000 - 25,000
## GIS Software Adoption (by # of Signs in Jurisdiction)

<table>
<thead>
<tr>
<th># of Signs under Jurisdiction</th>
<th>Inventoried and managed via GIS</th>
<th>Inventoried manually</th>
<th>Neither</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 2,000</td>
<td>5%</td>
<td>3%</td>
<td>6%</td>
</tr>
<tr>
<td>2,000 - 10,000</td>
<td>18%</td>
<td>13%</td>
<td>12%</td>
</tr>
<tr>
<td>10,000 - 25,000</td>
<td>14%</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>25,000 - 50,000</td>
<td>3%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>50,000 +</td>
<td>8%</td>
<td>1%</td>
<td>2%</td>
</tr>
</tbody>
</table>

- **Inventoried and managed via GIS**: The percentage of signs that are inventoried and managed using GIS software.
- **Inventoried manually**: The percentage of signs that are inventoried manually.
- **Neither**: The percentage of signs that are not inventoried or managed using GIS software.
Primary Method of Sign Inspection

- Visual Inspection
- Sign life replacement
- Blanket replacement
- Control sign sampling
- Retroreflectometer readings

Legend:
- 50,000 +
- 25,000 - 50,000
- 10,000 - 25,000
- 2,000 - 10,000
- Under 2,000
A Closer Look at Visual Inspections…

- Both
- Daytime Inspections
- Nighttime Inspections

- 50,000 +
- 25,000 - 50,000
- 10,000 - 25,000
- 2,000 - 10,000
- Under 2,000
Signs in the Field

PASS

- HI Guide Sign
- BG = 60.2 (min 15)
- L = 296 (min 120)
- 1988 = 23 years old
A deeper look…

129 Survey Respondents March – April 2012
The importance of the following in regards to the goals of the agency's sign department:

- Optimizing Work Assignments: 36% Very Important, 48% Important, 12% Neutral, 3% Unimportant, 1% Very Unimportant
- Being MUTCD Compliant: 66% Very Important, 28% Important, 5% Neutral, 3% Unimportant, 2% Very Unimportant
- Saving Money by Saving Signs from Unnecessary Replacements: 51% Very Important, 32% Important, 12% Neutral, 3% Unimportant, 2% Very Unimportant
- Monitoring Minimum Retroreflectivity: 34% Very Important, 47% Important, 17% Neutral, 2% Unimportant, 1% Very Unimportant
- Proactively Monitoring Sign Inventory: 41% Very Important, 42% Important, 15% Neutral, 1% Unimportant, 1% Very Unimportant
How Agencies with Programs in Place are Utilizing the Sign Data Collected

- Sign Inventory Mapping: 53%
- Creating a Prioritized Punch list for Maintenance / Replacement: 51%
- Setting Reevaluation Dates for Retroreflectivity Measurements: 16%
- Determining Field Sign Life: 46%
- Budgeting Decisions: 40%
Types of Sign Attributes Agencies with Programs are Collecting

- GPS Location
- Sign Post Type
- Installation Date
- Sign Size
- Sign Sheeting
- MUTCD / DOT Icon Code
- Direction Facing
- Retroreflectivity
- Last Inspection Date
- Cross-roads / Closest Street
- Inventory Number
- Sign Height
- Distance from the Road
- Asset Barcode
- Special Attributes
- Sign Installation Cost
- Sign Material Cost
- Warranty Expiration
- View-able Distance

- Under 2,000
- 2,000 - 10,000
- 10,000 - 25,000
- 25,000 - 50,000
- 50,000 +
A Few other Interesting Findings...

* 7% Currently Outsource Sign Management to a 3rd Party Contractor

* 79% have a Management Program Currently in Place; however, 6% of those with a Program haven’t incorporated retroreflectivity monitoring yet
Signs in the Field

FAIL

- EG Symbol Sign
- BG = 2.4 (min 75)
- L = Black
- 2008 = 3 years old
PPP Customer Program Snapshots
NYC Overhead Sign Project

* 1,283 Overhead Structures – 2,000 Signs
* Majority of signs replaced 14 -15 years ago in 1997
* Currently just over 25% Project Completion

Results so far at 500 Signs Tested to Date...
* 1% Retro Fail Rate
* Averaging 100-115% higher than MUTCD minimums
* Clientele mostly Rural Townships

* 6,936 Regulatory and Warning Signs Inspected over 2 year period
  - 68% Failed daytime visual inspection due to physical damage (sa. Holes, graffiti, cracked, faded, etc.) or substandard material (sa. EG Sheeting)
  - 32% Tested with Retroreflectometer
    - 16% Failure Rate of those tested

* Clients average 35% savings over Blanket Replacement
Upstate NY Project

- 8,000 signs inspected on 600 miles of rural roads
- Strictly collecting Retro, GPS and Sign IDs for appending existing Cartegraph GIS data

- 10% Retro Fail Rate
Portland Scope Pilot

* Relatively small sample of 398 signs
  - Random sample method
  - Split 50/50 between Stop Signs and black & white Regulatory Signs only
  - Average sign age of 10 years, ranging from New (0) to 26 years
  - 1st pass was daytime physical inspections; 2nd pass was retro readings

* 67% of sample showed some kind of damage – either human or environmental (dirt / algae)
  - 40% of sample had graffiti-related damage
  - 12% of sample had been stolen or knocked down and not reported

* 65% of sample read with retroreflectometer
  - 1.5% Retro Failure Rate (of those actually read) = 4 signs
  - No correlation could be observed between Visual Inspection and Retro Readings

* Results suggest **33x more** likely to replace signs due to Physical Damage than due to low Retroreflectivity
Signs in the Field

PASS

- HI Stop Sign
- South Facing
- BG = 16.3
- L = 115
- Feb ‘88 = 23 years old
In General...

The Word from the Streets
In General...

* Sign Inspections as part of a Pilot or Study have a lower signs/day
  - Reports range from 8 – 19 an hour
  - Consultants’ report 15 – 30 an hour
  - All say distance between signs is the biggest determinant of inspection efficiency

* Regulatory and warning signs make up 30-40% of total sign inventories

* HI sheeting is out lasting predictions in the field by 2-3x expected sign life
In General…

* Reports of as much as 20-25% of signs being inventoried made of EG sheeting

* Much more likely to have a sign failure due to physical damage than due to retroreflectivity issues

* Laptop with GIS/Mapping versus Paper-based manual reference in field increases productivity by as much as 50%

* Reported savings of 30-40% using Retroreflectometer Inspections versus Blanket Replacement
At Professional Pavement Products, everything we do is in an effort to promote roadway safety. Products. Service. Knowledge.

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