Conducting Sign Retroreflectivity Inspections

Training for Conducting Visual Sign Retroreflectivity Inspections and Measuring Retroreflectivity of Traffic Signs
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
Course Instructor(s)

• Names
  – Short bio
Participant Introductions

- Name
- Agency
- Position/duties
Purpose of Course

• Provide background information
• Describe MUTCD
• Review new MUTCD minimum retroreflectivity requirements
• Understand sign inspection methods that can be used to evaluate sign retroreflectivity in compliance with new requirements.
• Learn traffic sign inspection techniques that can assess retroreflectivity
## Content & Schedule

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welcome</td>
<td>15</td>
</tr>
<tr>
<td>Background</td>
<td>20</td>
</tr>
<tr>
<td>Retroreflectivity</td>
<td>40</td>
</tr>
<tr>
<td>New retroreflectivity requirements</td>
<td>15</td>
</tr>
<tr>
<td>Training Slides</td>
<td></td>
</tr>
<tr>
<td>– Visual Inspection Methods</td>
<td></td>
</tr>
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<td>• Comparison Panel Procedure</td>
<td>30</td>
</tr>
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<td>• Calibrated Signs Procedure</td>
<td>30</td>
</tr>
<tr>
<td>• Consistent Parameters Procedure</td>
<td>30</td>
</tr>
<tr>
<td>– Retroreflectivity Measurements</td>
<td>30</td>
</tr>
<tr>
<td>Resources</td>
<td>5</td>
</tr>
</tbody>
</table>
Questions
Why Do We Install Signs?

**Required by MUTCD?**
NO

**Engineering Decision?**
YES!

**Why?**
To help drivers safely navigate roadways (including older)
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

Manual on Uniform Traffic Control Devices

• 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.
MUTCD

- 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).
MUTCD

• 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.
MUTCD Sign Maintenance

MUTCD Section 2A.22 Maintenance

Maintenance activities should consider proper position, cleanliness, legibility, and daytime and nighttime visibility (see Section 2A.09). Damaged or deteriorated signs should be replaced.

To assure adequate maintenance, a schedule for inspecting (both day and night), cleaning, and replacing signs should be established.

Steps should be taken to see that weeds, trees, shrubbery, and construction, maintenance, and utility materials and equipment do not obscure the face of any sign.
More than just Retroreflectivity

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

![Graph showing the number of fatalities per million miles traveled (2004-2006) during nighttime versus daytime. The graph indicates a higher number of fatalities during nighttime. Source: National Safety Council]
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 complementary

Nighttime signing here is necessary
Another Day/Night Example
Another Example
Another Example
Daytime sign visibility can be low

But…
what about nighttime visibility?
Retroreflectivity Concepts
RETROreflection

Matte or Diffuse Reflection

Mirror-like Reflection (Specular)
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

\[
\frac{\text{Light OUT of sign}}{\text{Light INTO sign}} = \text{Retroreflectivity}
\]
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
Sign Sheeting

Exposed Lens Sheeting
(First Retroreflective Sheeting)

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

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

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

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

Prismatic Lens Sheeting
Video Demonstration
Retroreflectivity Cone

Reflected light is brighter near light axis.

Reflected light gets dimmer as distance from light axis increases.
Flashlight Demonstration - Cone

Greg will get sample materials
Cone Size is Important

*Cone of Retroreflection*
Key Geometry Angles

**Observation angle (α)**
Between source and receptor (red and blue lines)

**Entrance angle (β)**
Between source and target axis (blue and green lines)

Perpendicular to sign
Flashlight Demonstration – Retroreflective Angles

Need photo of demo signs
Key Geometry Angles

**Observation angle (α)**
Between source and receptor (red and blue lines)

**Entrance angle (β)**
Between source and target axis (blue and green lines)

Perpendicular to sign
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?
Questions
Questions for You

• What is unique about RETROreflection?

• Where do you find examples of retroreflection?

• Why is the cone of retroreflection important?
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
New MUTCD Language
Section 2A.09 Maintaining Minimum Retroreflectivity

• “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”
New MUTCD Language
Section 2A.09 Maintaining Minimum Retroreflectivity

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

<table>
<thead>
<tr>
<th>Sign Color</th>
<th>Sheet Type (ASTM D4956-04)</th>
<th>Additional Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beaded Sheeting</td>
<td>Prismatic Sheeting</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>White on Green</td>
<td>W*</td>
<td>W*</td>
</tr>
<tr>
<td></td>
<td>G ≥ 7</td>
<td>G ≥ 15</td>
</tr>
<tr>
<td></td>
<td>W*</td>
<td>G ≥ 7</td>
</tr>
<tr>
<td>Black on Yellow or Black on Orange</td>
<td>Y*; O*</td>
<td>Y ≥ 50; O ≥ 50</td>
</tr>
<tr>
<td></td>
<td>Y*; O*</td>
<td>Y ≥ 75; O ≥ 75</td>
</tr>
<tr>
<td>White on Red</td>
<td>W ≥ 35; R ≥ 7</td>
<td>④</td>
</tr>
<tr>
<td>Black on White</td>
<td>W ≥ 50</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.
### 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.

#### Retroreflective Sheeting Materials for Rigid Sign Surfaces Made with Glass Beads

<table>
<thead>
<tr>
<th>Example of Sheeting</th>
<th>(Shown to scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM Type</td>
<td>I</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>See note A</td>
</tr>
<tr>
<td>Brand Name</td>
<td>Engineer Grade</td>
</tr>
<tr>
<td>Series Number</td>
<td>Several</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASTM Type</th>
<th>II</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>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>
<td>Nippon Carbide</td>
</tr>
<tr>
<td>Brand Name</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>
<td>High Intensity</td>
</tr>
<tr>
<td>Series Number</td>
<td>T-2000</td>
<td>15000</td>
<td>17000</td>
<td>18000</td>
<td>2800</td>
<td>3800</td>
<td>ASTM HI</td>
<td>T-5500</td>
</tr>
</tbody>
</table>

**NOTES:**
- A

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

<table>
<thead>
<tr>
<th>Example of Sheeting</th>
<th>(Shown to scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM Type</td>
<td>III, IV</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Avery Dennison®</td>
</tr>
<tr>
<td>Brand Name</td>
<td>High Intensity Prismatic</td>
</tr>
<tr>
<td>Series Number</td>
<td>T-6500</td>
</tr>
</tbody>
</table>

**NOTES:**
- B
- B
- B,D
- B,C
- C
- 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.
What signs need replaced?

*Pictures do not accurately show retroreflectivity!*
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
Summary

• Do the new MUTCD requirements specify how often you need to inspect your signs for retroreflectivity?

• If the requirements are in the MUTCD, what types of roads need to be in compliance?

STOP STOP STOP STOP
Can we decide to replace signs based on daytime inspections?
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)
Training for Inspectors
MUTCD Methods

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

www.fhwa.dot.gov/retro
Methods Using Inspection

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

• Retroreflectivity Measurement Method
  – Measurements made with Hand-Held Devices
Visual Inspection Requirements

- Trained inspector
- Nighttime inspection
- Need to tie to minimum values by using one of the following techniques
  - Comparison panels procedure, or
  - Calibration signs procedure, or
  - Consistent parameters procedure
Visual Inspection Method:
Comparison Panel Procedure
New MUTCD Language

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

- Visual Nighttime Inspection
  - Comparison Panels
  - Calibration Signs
  - Consistent Parameters
- Measured Sign Retro

- Expected Sign Life
- Blanket Replacement
- Control Signs
- Future Method Based On Engr. Study
- Combination Of Any
Overview

• Any vehicle, any inspector age is OK.
• The “initial” inspection occurs at highway speeds.
• When a marginal sign is spotted,
  – Safely pull over to inspect the sign,
  – Install comparison panel on the sign,
  – Evaluate from at least 25 feet,
  – Hold a flashlight near inspector’s ear.
Comparison Panels

• Comparison panels must have a retroreflectivity level at least that designated in the MUTCD
• The procedure must be done at night

These panels have retroreflectivity levels at the levels in the MUTCD minimum retroreflectivity table
# New MUTCD Table 2A.3
## Minimum Maintained Retroreflectivity Levels

<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>W* G ≥ 7</td>
<td>W* G ≥ 15</td>
<td>W* G ≥ 25</td>
<td>Overhead</td>
</tr>
<tr>
<td></td>
<td>W* G ≥ 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black on Yellow or Orange</td>
<td>Y*; O*</td>
<td></td>
<td>Y ≥ 75; O ≥ 75</td>
<td>③</td>
</tr>
<tr>
<td>White on Red</td>
<td></td>
<td>W ≥ 35; R ≥ 7</td>
<td></td>
<td>④</td>
</tr>
<tr>
<td>Black on White</td>
<td></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.
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.
- As of June 2008, there are no known sources for ordering comparison panels.
Field Procedure

Comparison Panel Procedure
Field Procedure

Comparison Panel Procedure
Pass or Fail?
Pass or Fail?

Comparison Panel Procedure
Pass or Fail?

Comparison Panel Procedure
Pass or Fail?

Comparison Panel Procedure
Comparison Panel Demonstration Using MiniSigns

- Need comparison panels.
- Commercial grade yellow.
- 3 x 6 inch substrates
- 100 panels.
- Sticker for back that says for demo purposes only
- Send finished product to Greg.
- AD commercial grade ordered (June 11)
- Centerline DFW making panels (July 16)
Comparison Panel Checklist

- Be well rested
- Select inspection vehicle and have headlamps aimed
- Select inspection routes (both directions)
- Prepare inspection forms (example shown later)
- Have sign list if available (for each inspection route, a list of signs you expect to see, in order of the direction of travel)
- Clip board, pen lights, dash cam, tape recorder, laptop,
- Comparison panels
- Ladder
- Retroreflective garments
- Flashing lights for safety when installing comparison panel
- Cannot start in earnest until complete darkness
Pass or Fail?
Quiz

• How often do you need to stop and use the comparison panels?
• What size do the comparison panels need to be?
• What color do the panels need to be?
• What retroreflectivity level should the panels be?
Inspection Method:
Calibrated Signs Procedure
New MUTCD Language

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

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

• Any vehicle, any inspector age is OK.
• Before leaving the maintenance yard, the inspectors visually inspects a set of representative signs in an effort to calibrate their eye before starting the nighttime inspections.
• The calibration signs should be viewed at distances from 600 to 100 feet
• Use low beams.
• The inspection occurs at highway speeds.
Calibration Signs

- Calibration signs must have a retroreflectivity level at least that designated in the MUTCD
- The inspection has to be done at night
### New MUTCD Table 2A.3
Minimum Maintained Retroreflectivity Levels

<table>
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<tr>
<th>Sign Color</th>
<th>Sheeting Type (ASTM D4956-04) ¹</th>
<th>Additional Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beaded Sheeting</td>
<td>Prismatic Sheeting</td>
</tr>
<tr>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>White on Green</td>
<td>W* G ≥ 7</td>
<td>W* G ≥ 15</td>
</tr>
<tr>
<td></td>
<td>W* G ≥ 15</td>
<td>W* G ≥ 25</td>
</tr>
<tr>
<td></td>
<td>W* G ≥ 7</td>
<td>W ≥ 250; G ≥ 25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overhead</td>
</tr>
<tr>
<td></td>
<td>W* G ≥ 7</td>
<td>W ≥ 120; G ≥ 15</td>
</tr>
<tr>
<td>Black on Yellow or Orange</td>
<td>Y*; O*</td>
<td>Y ≥ 50; O ≥ 50</td>
</tr>
<tr>
<td></td>
<td>Y*; O*</td>
<td>Y ≥ 75; O ≥ 75</td>
</tr>
<tr>
<td>White on Red</td>
<td>W ≥ 35; R ≥ 7</td>
<td>⁴</td>
</tr>
<tr>
<td>Black on White</td>
<td>W ≥ 50</td>
<td>—</td>
</tr>
</tbody>
</table>

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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.
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.

• As of June 2008, there are no known sources for ordering calibrated signs.
Field Procedure

These signs have retroreflectivity levels at the levels in the MUTCD minimum retroreflectivity table

Calibrated Signs Procedure
Field Procedure

• Use the same vehicle that will be used during the visual inspection
• View the calibration signs from the inspection vehicle at distances from 600 feet to 100 feet before leaving the maintenance yard / parking lot
• 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.
Quiz

• What type of vehicle is needed for this method?
• How old does the inspector need to be?
• How does this method compare to the comparison panel method?
• How many calibration signs do you need?
Checklist

• Be well rested
• Select inspection vehicle and have headlamps aimed
• Select inspection routes (both directions)
• Prepare inspection forms (example shown later)
• Have sign list if available (for each inspection route, a list of signs you expect to see, in order of the direction of travel)
• Clip board, pen lights, dash cam, tape recorder, laptop,
• Cannot start in earnest until complete darkness
• View calibration signs before starting your inspection routes
6 different types of material used on these Stop signs
7 different types of material used on these Stop signs
Visual Inspection Method:
Consistent Parameter Procedure
New MUTCD Language

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

- Visual Nighttime Inspection
  - Comparison Panels
  - Calibration Signs
  - Consistent Parameters
- Measured Sign Retro

- Expected Sign Life
- Blanket Replacement
- Control Signs
- Future Method Based On Engr. Study
- Combination Of Any
Overview

• With this method, a SUV or truck has to be used with specific headlamps (described later) 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.
Headlamp Identification

Consistent Parameter Procedure
Field Technique

- Preferable to use a two person crew.
- Must have a SUV, pick-up, or similar vehicle with VOA style headlamps.
- Driver can be any age but inspector needs to be at least 60 years old.
- Inspection occurs at highway speeds.
- Inspector concentrates on judging sign retroreflectivity.
  - Example: adequate, marginal, poor (replace)
- Driver concentrates on driving safely.
Quiz

• What are the advantages of this method?
• What are the limitations of this method?
• Of all the visual inspections methods, which is your preferred method? Why?
  – Comparison Panels
  – Calibration Signs
  – Consistent Parameters
Checklist

- Inspector and driver need to be well rested
- Have SUV/ Truck vehicle with VOA headlamps aimed properly
- Have routes selected
- Prepare enough inspection forms
- Have sign list if available
- Clip board, pen lights, dash cam, tape recorder, laptop,
- Be fueled up
- Cannot start in earnest until complete darkness
- Remember to evaluate both colors of signs with two retroreflective colors (white on green, white on red, etc.)
New MUTCD Language

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

- Visual Nighttime Inspection
  - Comparison Panels
  - Calibration Signs
  - Consistent Parameters
- Measured Sign Retro
- Expected Sign Life
- Blanket Replacement
- Control Signs
- Future Method Based On Engr. Study
- Combination Of Any
Common Visual Inspection Features

• Aim inspection vehicle headlamps (take to certified auto mechanic)
• Two-person crew works best
• Having an inventory is preferred
• Use low-beam headlamps
• Have evaluation form and criteria
  – Example: good or bad (replace)
• Conduct evaluations at roadway speed
Visual Inspection Tips

• It is preferred to have a list of the signs along the inspection route.
  – Adds consistency to the inspections
  – Reduced need for writing during inspection
    • Only need a score for each sign such as: good, marginal, replace.
  – Provides documentation that the inspections were conducted --- just in case!
  – Allows identification of missing signs
## Sign List Example

### Sign Retroreflectivity Inspection Form

<table>
<thead>
<tr>
<th>Date:</th>
<th>Route start point:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspector:</td>
<td>Route end point:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sign Description</th>
<th>Sign Color</th>
<th>Odom. Reading</th>
<th>RETROREFLECTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop</td>
<td>Red</td>
<td>0.1</td>
<td>☑️</td>
</tr>
<tr>
<td>Route Mkr</td>
<td>Wht</td>
<td>0.2</td>
<td>☑️</td>
</tr>
<tr>
<td>Spd Lmt</td>
<td>Wht</td>
<td>0.5</td>
<td>☑️</td>
</tr>
</tbody>
</table>
Retroreflectivity Measurement Method
New MUTCD Language

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

• Visual Nighttime Inspection
  – Comparison Panels
  – Calibration Signs
  – Consistent Parameters

• Measured Sign Retro

• Expected Sign Life
• Blanket Replacement
• Control Signs
• Future Method Based On Engr. Study
• Combination Of Any
Overview

• This method includes sign retroreflectivity measurements of in-service signs
• The measurements are made with devices similar to cordless drills
• The measurement devices must be in contact with the sign face
• The measurements need to be periodically repeated (e.g., annually or every other year)
Sign Sheeting Degrades over Time

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Day</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Retroreflectivity</td>
<td>Type I</td>
</tr>
</tbody>
</table>

![Graph showing the degradation of sign sheeting over time by type and time of day.](image)
Devices Available in the US

* as of June 2008

Model 922
by Road Vista
http://www.roadvista.com

Model GR3
by Delta
http://www.tapconet.com/digital

* FHWA does not endorse specific products
Available Features

- **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 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
Important Common Features

• Measurements are provided at standard geometry (defined by ASTM)
  – 0.2 degree observation angle
  – -4.0 degree entrance angle
• Ability to store data
• Easy to use
• Rechargeable batteries
Important Distinctions

• RoadVista Model 922
  – Annular Device

• Delta RetroSign GR3
  – Point Device
Practical Differences

• Sign sheeting materials made with glass beads - NONE

• Sign sheeting materials made with prisms
  – Measurements from different devices can be as much as 25% different.

• Always make measurements with devices held at the same orientation
Measurement Rotation Example

• 0 degree rotation
Measurement Rotation Example

• 45 degree rotation
Measurement Rotation Example

- 90 degree rotation
Measurement Rotation Example

Results (Observation = 0.2°)

- Retroreflectivity
- Minimum Retro

Bar chart showing retroreflectivity at 0°, 45°, and 90°.
Field Procedure

• Make note of the type of sheeting
• Measure each color that is retroreflective
• Multiple measurements should be made to compute an average
• A measurement protocol should be developed
• An extension pole or ladder will be needed
# 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.

## Retroreflective Sheeting Materials for Rigid Sign Surfaces Made with Glass Beads

<table>
<thead>
<tr>
<th>ASTM Type</th>
<th>I</th>
<th>II</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>
<td>Nippon Carbide</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>
<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>
<td>T-5500</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.
Measurement Protocol
Example

• For Stop signs, an agency may require a minimum of 4 measurements per color as shown to the left.
• The average of the 4 measurements would be used to assess the condition of the sign retroreflectivity.
## New MUTCD Table 2A.3
Minimum Maintained Retroreflectivity Levels

<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></td>
<td>I</td>
<td>II</td>
<td>III</td>
<td></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>Ground-mounted</td>
</tr>
<tr>
<td>Black on Yellow or Orange</td>
<td>Y*; O*</td>
<td>Y ≥ 50; O ≥ 50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y*; O*</td>
<td></td>
<td>Y ≥ 75; O ≥ 75</td>
<td></td>
</tr>
<tr>
<td>White on Red</td>
<td></td>
<td>W ≥ 35; R ≥ 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black on White</td>
<td></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).

* This sheeting type should not be used for this color for this application.
# New MUTCD Table 2A.3
## Minimum Maintained Retroreflectivity Levels

<table>
<thead>
<tr>
<th>Sign Color</th>
<th>Sheet Type (ASTM D4956-04)</th>
<th>Additional Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>White on Green</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beaded Sheeting:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>$W^* \geq 7$</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>$W^* \geq 15$</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>$W^* \geq 25$</td>
<td></td>
</tr>
<tr>
<td>Prismatic Sheeting:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III, IV, VI, VII, VIII, IX, X</td>
<td>$W \geq 250; G \geq 25$</td>
<td>Overhead</td>
</tr>
<tr>
<td>II</td>
<td>$W \geq 120; G \geq 15$</td>
<td></td>
</tr>
<tr>
<td>Ground-mounted</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Black on Yellow or Black on Orange</strong></td>
<td>$Y^<em>; O^</em> \geq 75; O \geq 75$</td>
<td></td>
</tr>
<tr>
<td><strong>White on Red</strong></td>
<td>$W \geq 35; R \geq 7$</td>
<td></td>
</tr>
<tr>
<td><strong>Black on White</strong></td>
<td>$W \geq 50$</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.
Contrast Ratio

- For red and white signs, there is a contrast ratio requirement of ≥ 3.

- Contrast ratio equals:

  \[
  \frac{\text{Average of white measurements}}{\text{Average of red measurements}}
  \]

- Faded or pink looking Stop signs indicate that the contrast ratio may be too low for nighttime driving.
Measuring Letters
Measuring Letters

The reduction cap decreases the aperture size to 0.5 inch
Taking Measurements

• You will be in the ROW so safety is ultimately the highest priority
• Signs are usually out of reach so a ladder or extension pole will be needed.
• For overhead signs, a bucket truck will be needed.
• The device memory can be used to save the readings or a notepad or a palm device
Taking Measurements
Orientation of Sign Sheeting
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.
Quiz

• How many measurements are needed on each sign?
• How often should signs be measured?
• Should you clean the sign before taking a measurement?
• Would you rather measure signs during the daytime or conduct a nighttime inspection technique as described earlier?
Additional Considerations

• Will the methods we reviewed today be effective in all conditions?

• Can you think of some other field methods that might be used to evaluate traffic sign retroreflectivity?
Sign Conditions
Rural vs Urban Areas

• The minimum retroreflectivity levels in the MUTCD are based on
  – Older drivers vision
  – Sign recognition and legibility
  – Rural areas without background complexity

• What happens in urban areas?
Can you see the sign?
New MUTCD Language

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

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

• Your local LTAP Center
  – Some have retroreflectometers for loan

• Methods for Maintaining Traffic Sign Retroreflectivity, 2007
  – FHWA-HRT-08-026

• FHWA  fhwa.dot.gov/retro

• ATSSA  www.retroreflectivity.net
Your job is the most important part of making this new regulation successful.

Increase safety
Increase nighttime visibility