



Retroreflectivity of pavement markings and signs: *Why is it important? How do I measure it?*

IMS Infrastructure Management Services, LP
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Core Engineering Team



Kurt Keifer, PhD, PE
Principal Engineer
President



Sadaf Khosravifar, PhD, PE
Project Manager



Dave Bratton, PE
QA Manager

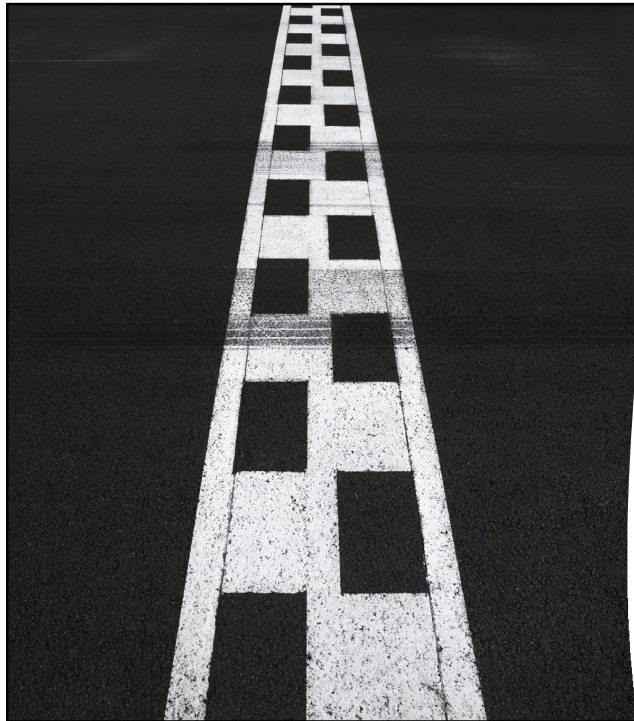


Megan Foshee, EIT
Project Engineer



Mostafa Nakhaei, PhD, EIT
Project Engineer and
Data Scientist

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Agenda

- ❖ **Definitions and background**
- ❖ Retroreflectivity of pavement markings
- ❖ Retroreflectivity of signs

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Why is Pavement Marking Retroreflectivity Important?

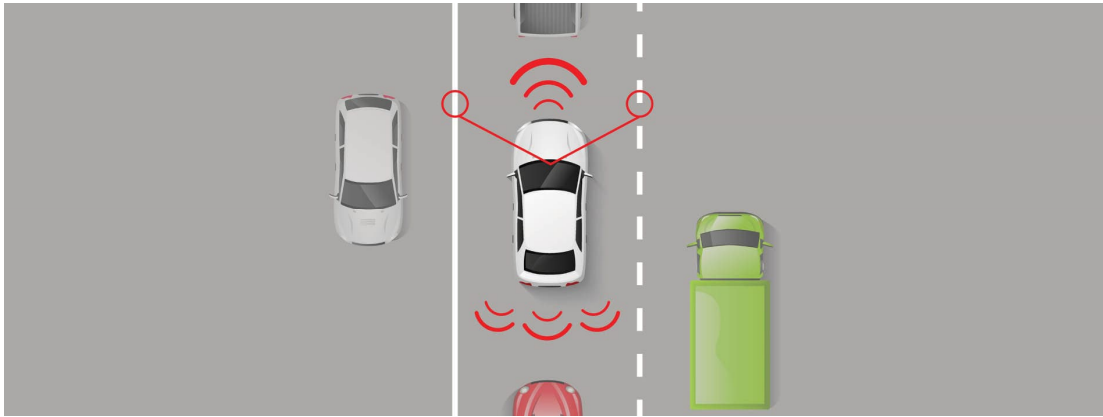
Objective: Reduce collisions and roadway departures, saving lives!

Lane markings must be visible to:

- Human drivers
- Advanced driver assistance systems (ADAS)

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Future (...now) Trends



OEM vehicle & ADAS manufacturers require **Good Quality** visible road markings in dry/wet conditions day & night for their technologies to operate safely.

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Advanced Driver Assistance Systems (ADAS)

ADAS Type	Uses Lane Markings
Adaptive Cruise Control (ACC)	No
Automatic Emergency Braking (AEB)	No
Blind Spot Warning (BSW)	No
Forward Collision Warning (FCW)	No
Forward Collision Prevention (FCP)	No
Parking Assist	No
Lane Departure Warning (LDW)	Yes
Lane Keeping Assist (LKA)	Yes
Rear Cross Traffic Alert (RCTA)	No
Active Driving Assistance (Level 2 Automation)	Yes

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New FHWA requirements

- Manual on Uniform Traffic Control Devices (MUTCD) has been updated to include new requirements:
- The minimum retroreflectivity of longitudinal pavement markings is **50 mcd/m²/lux** on roads with speed limits of 35 mph or greater, where average annual daily traffic is 6,000 vehicles per day.
- The minimum retroreflectivity of longitudinal pavement markings is **100 mcd/m²/lux** on roads with speed limits of 70 mph or greater.
- **These MUTCD changes are effective from 6 September 2022 and road authorities and Departments of Transportation have a 4-year period to comply with the new rulings.**

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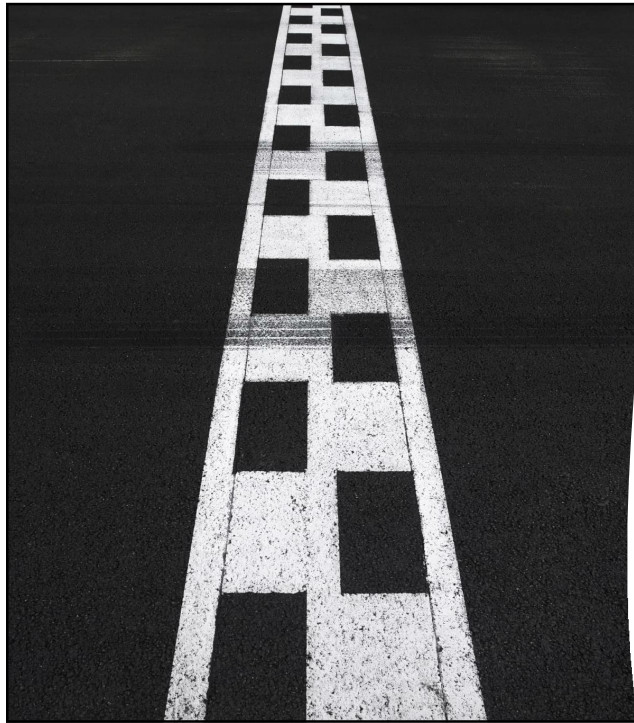
New FHWA requirements

There are a few different methods allowed to maintain minimum retroreflectivity values, which are described in FHWA-SA-14-017 Methods for Maintaining Pavement Marking Retroreflectivity.

- **Measured Retroreflectivity**
- **Nighttime Visual Inspections**
 - Consistent Parameters
 - Calibrated Pavement Markings
- **Service Life Replacement**
 - Based on Historical Data
 - Based on Monitored Markings

While not all methods require a retroreflectometer, use of a retroreflectometer takes the subjectivity out of the equation and is a very cost-effective way to ensure compliance, especially compared to service life replacement based on historical data and nighttime visual inspections using consistent parameters.

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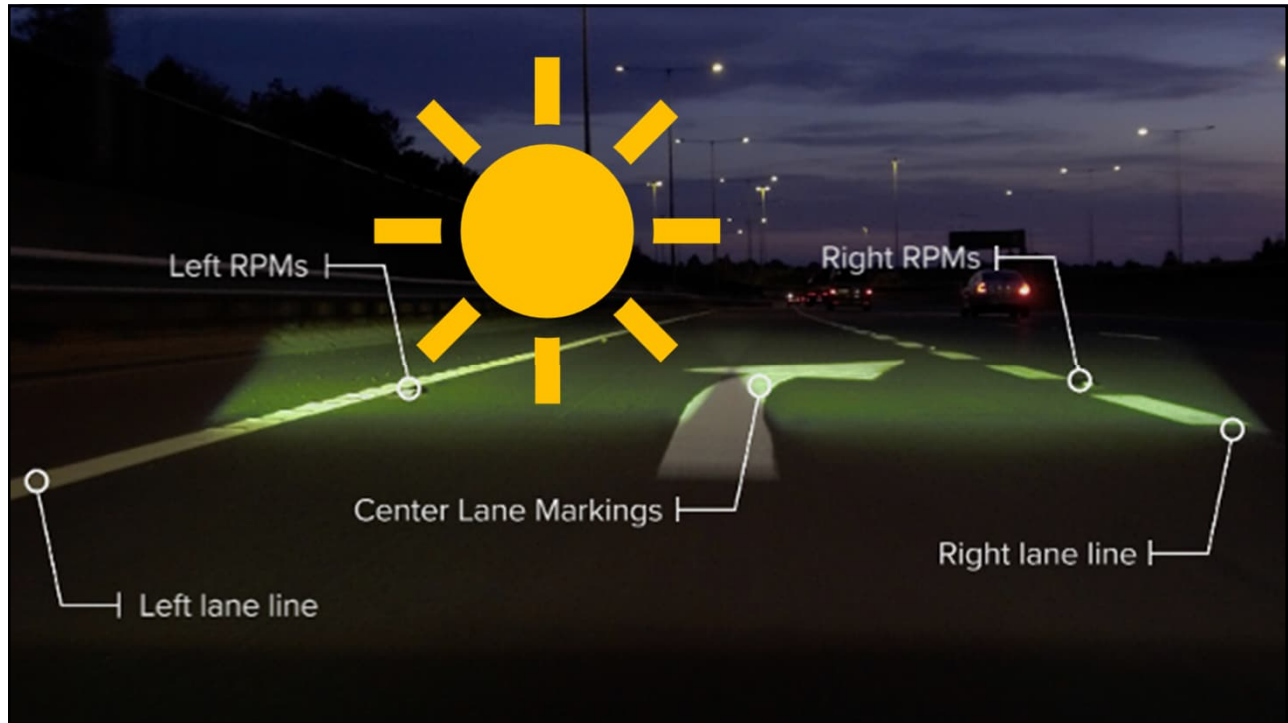
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- ❖ **Retroreflectivity of pavement markings**
- ❖ Retroreflectivity of signs

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Collecting Pavement Marking Reflectivity

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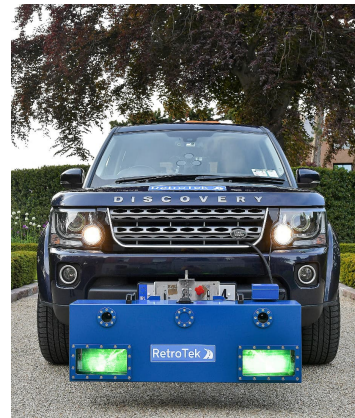
Types of Retroreflectometer Systems



Handheld



Side Mounted



Front Mounted

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RetroTek-D System

- The RetroTek-D mobile retroreflectometer measures road markings across **the full width of a lane** in a single pass.
- It records all road markings to the left and right sides of the lane, plus all central markings along with the absence and presence of reflective pavement markings and road studs.
- The RetroTek-D fixes securely to the front hitch mount of the survey vehicle; no unsightly or dangerous protrusions from the side of the vehicle.



Retrotek-M (night-time only)



Retrotek-D (day- or night-time)

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Other Systems

USA: RoadVista (Gamma Scientific)

<http://www.roadvista.com/laserlux-mobile-retroreflectometer/>



RoadVista Laserlux G7

Europe: Delta LTL-M

<https://roadsensors.madebydelta.com/products/ltl-m-mobile-retroreflectometer-road-markings/>



Delta LTL-M

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Benefits of Front Mounted Retroreflectometer



- Safer to Use
 - Does not protrude from side of vehicle so no danger to other road users
 - No necessity to leave vehicle to move sensor from side to side
 - Good pavement ground clearance and not vulnerable to damage
 - Driver can focus on surroundings as precision driving close to marking line not required
 - Minimum interaction with software - automated data collection



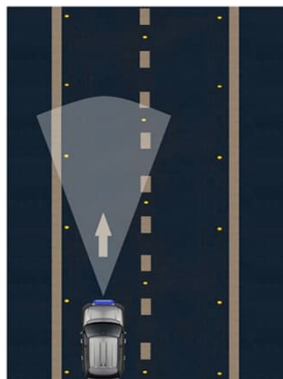
- More Productive
 - One pass per lane – capture all markings
 - Over 100% more efficient than side-mounted systems
 - Collects all markings - line markings, centre lane markings/symbols & raised pavement markers (RPM)



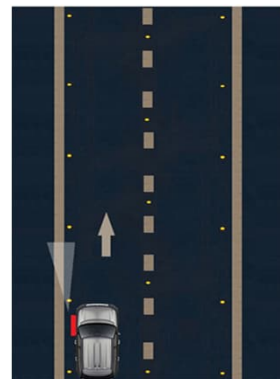
- Easy to Use
 - One operator/driver
 - Automated operation and easy to calibrate
 - Movable from vehicle to vehicle with front tow hitch bar
 - Minimal cleaning & replacement of sensor head (no dirt / damage from front wheels)

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More Efficient Collection



- All lane markings assessed in ONE pass
- RetroTek MRU Up to 5 Road Assets



- Only one side of lane measured in one pass
- Side-Mounted MRU Max 2 Road Assets

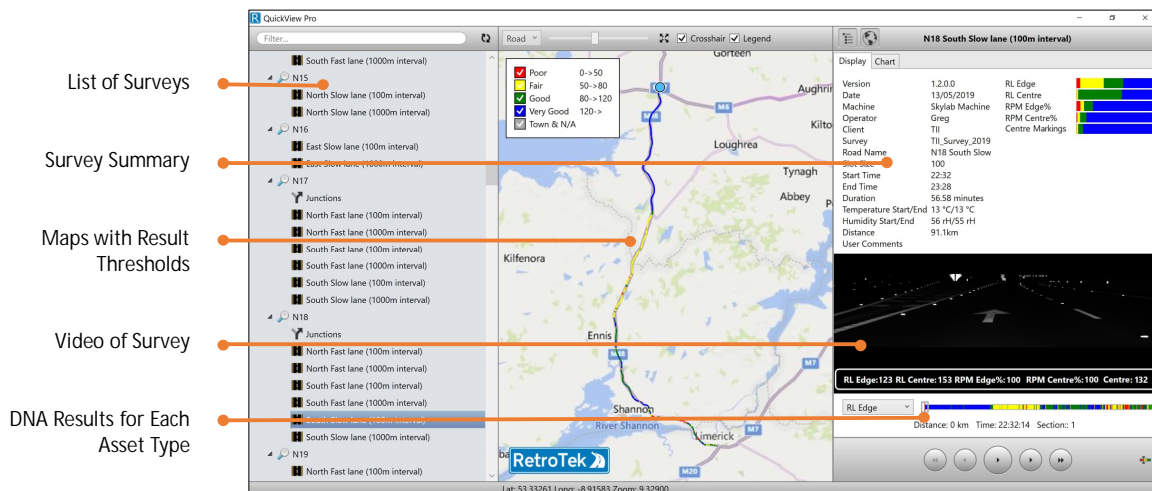
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Collection Software



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Processing and Viewing Software



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Data Capture and Output

- Data capture is run at fixed frequency (not fixed distance)
 - Strobes run at 60 Hz (to avoid causing visual distraction)
 - Cameras capture images at 20 Hz
- Results are written to CSV file during a run
- After the run, the data is passed to a results processing program which chops it into 20-100 m intervals → saved to CSV
- Images are saved as JPGs or video file
- KML and PDF report are generated also
- Able to produce a geospatial deliverable optionally tied to client's GIS and road sections

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Data Types Collected

1. Night-time visibility (RL) of all road markings (measured in mcd/m²/lux)
2. RL of right & left edge, centre lane markings & symbols (measured in mcd/m²/lux)
3. The absence and presence of RPMs / road studs / markers
4. Each line width
5. Day contrast ratio when surveyed in daylight (RetroTek-D)
6. Indicates if single or double lines (Auto Detection)
7. Indicates if skip or continuous lines (Auto Detection)
8. Indicates colour - white or yellow (Auto Detection)
9. Individual RL for each line in double lines.
10. Measurements all GPS tagged with map & video images
11. Road name & number
12. Temperature & humidity

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ASSET DETAILS	GIS LAYOUT AND SURVEY PHOTOS
<p>Road surface markings are used on paved roadways to provide guidance and information to drivers and pedestrians. Linear locations with condition attributes.</p> <ul style="list-style-type: none"> • Asset ID • GISID • Photo Image Link • Condition Rating <ul style="list-style-type: none"> • Ex: Good, Fair, Poor, • Stripe Type <ul style="list-style-type: none"> <i>Bike Lane Blue/Green</i> <i>Bike Lane Blue/Green Striped</i> <i>Cross Walk</i> <i>Delineators</i> <i>Hi-Visibility Cross Walk</i> <i>Hi-Visibility Cross Walk Angular Lines</i> <i>Hi-Visibility Cross Walk with Horiz Lines</i> <i>No Striping</i> <i>Quick Curb</i> <i>Raised reflective markers RMP</i> <i>Stop Bar</i> <i>White Dashed Single</i> <i>White Short Dashed Single</i> <i>White Solid Single</i> <i>Yellow Dashed Double</i> <i>Yellow Dashed Single</i> <i>Yellow Short Double Widely Spaced</i> <i>Yellow Solid Double</i> <i>Yellow Solid Single</i> <i>Yellow Solid/Dashed</i> <i>Yield Bar</i> • Comments 	<p>The GIS LAYOUT AND SURVEY PHOTOS section contains several images: a large aerial GIS map with colored overlays; a close-up of a road with yellow dashed double lines; a 3D rendering of a raised curb with reflective markers; a photo of a road with yellow dashed double lines; a photo of a road with a white stop bar; a photo of a road with yellow delineators; and a photo of a road with white delineators.</p>

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ASSET DETAILS

Traffic signs or road signs are designed to give instructions or provide information to road users. Point locations with condition attributes.

- **Asset ID**
- **GISID**
- **Photo Image Link**
- **Condition Rating**
 - Ex: Good, Fair, Poor (fail)
- **SIGN_CODE**
 - modified MUTCD codes and special codes
- **SIGN_DESCRIPTION**
 - General description of the sign face
- **SIGN_Support**
 - (see Support Types, SS_Types)
- **SIGN_SUBGROUP**
 - General Sign Category
 - R01_Stop and Yield
 - R02_Speed Regulation
 - R03_Turn & Lane Use
 - ...
- **SIGN_Direction**
 - Ex: N, NE, E, SE, ...
- **SIGN_Comment**

SURVEY PHOTOS AND DETAILS

TAPCO's Traffic Signs

Complete with the entire Standard Highway Signs Library

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Equipment Proudly Made in the USA

Pavement Data Acquisition Systems

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IrisPRO Pave™

ASTM E1655 Compliant

Safety
Travels at posted speed, and no traffic control is required

3D Pavement Imaging
Laser Crack Measurement System (LCMS) – Second Evolution
[ASTM D6433 PCI Surveys]

Inertial Profiler – International Roughness Index (IRI) – NCAT/TTI certified

360-Degree Imaging Right-of-way (ROW) asset data collection

Note: Manufactured by IMS/ICC -- We've got 8 systems!

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IMS Methodology of Surveys: Coverage

Manual PCI surveys based on approx. 10% sampling

Automated PCI surveys – Option 1
All lanes – Good for baseline surveys

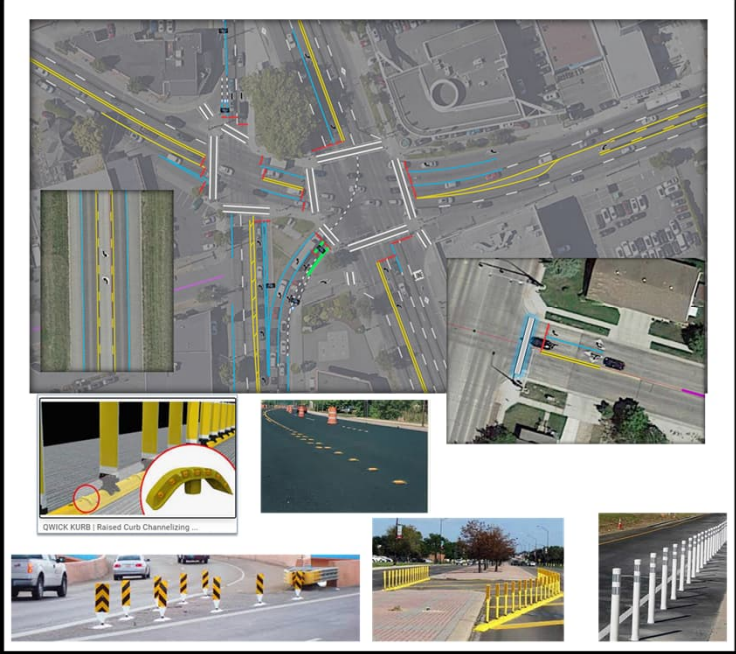
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Manual PCI surveys based on approx. 10% sampling

Automated PCI surveys – Option 2
Most common approach for routine surveys

IMS

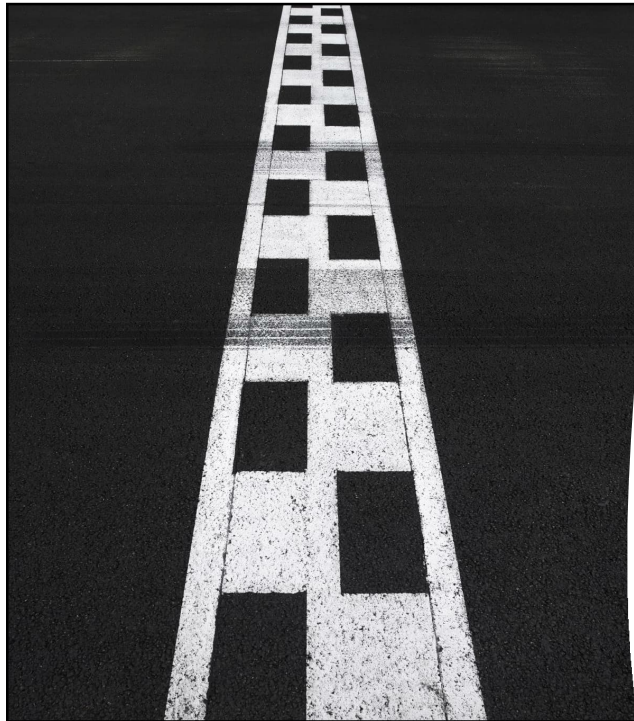
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- ❖ Definitions and background
- ❖ Retroreflectivity of pavement markings
- ❖ **Retroreflectivity of signs**

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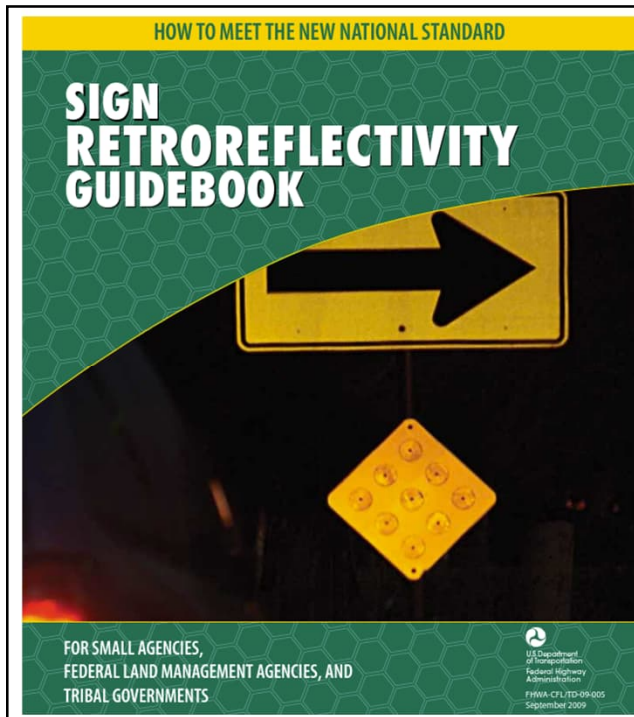


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Authors:
Paul Carlson
Dale Pich

Program Coordinators:
Ging Schertz
Kurt Lupak

Advisory Panel:
Roger Sardañ
Mark Coppock
Debbie Murrelo
Chris Fourtass

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Sign Retroreflectivity Manual: How to Meet the New National Standard for Small Agencies, Federal Land Management Agencies, and Tribal Governments

Sponsoring Agencies:
• Federal Highway Administration—Federal Lands Highway CTP Council
• Federal Highway Administration—Office of Safety

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Local Maintenance

This guidebook presents in detail what may be the most practical inspection method for smaller agencies: the Consistent Parameters Procedure of the Visual Inspection Method. Other methods are described in Appendix B beginning on page 42. For more information on these alternative methods, please reference the accompanying Sign Retroreflectivity Toolkit on CD-ROM.

Description of the Visual Inspection Method—Consistent Parameters Procedure

As implied by its name, the Visual Inspection Method relies on a visual inspection of signs at night to assess their compliance with the MUTCD's retroreflectivity requirements. Of all the maintenance methods listed in the MUTCD, the Visual Inspection Method is probably the most practical for a small agency with limited resources because it requires practically no additional equipment and no sign inventories.

The Visual Inspection Method includes three different procedures. Your agency must select one of the three procedures. The most practical procedure for small agencies is the Consistent Parameters Procedure. The other two procedures included in the Visual Inspection Method are the Calibrated Signs Procedure and the Comparison Panel Procedure. Both of these procedures require special signs or panels that must be purchased or fabricated. The signs and panels also require special handling and storing. For these reasons,

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- ◆ Describes the Consistent Parameters Procedure for the Visual Inspection Method
- ◆ Lists the Consistent Parameter procedure requirements
- ◆ Suggests guidelines for establishing your inspection program

The Visual Inspection Method is most practical for smaller agencies that have limited resources.

CHECKLIST FOR ESTABLISHING AN INSPECTION PROCEDURE

- Consistency of testing conditions
- Vehicle speed
- Vehicle position
- Headlamp type
- Procedural safety issues
- Recordkeeping
- Replacement
- Frequency
- Compliance Dates

the Consistent Parameters Procedure of the Visual Inspection Method is probably the most practical way for small agencies to meet the MUTCD minimum sign retroreflectivity requirements.

Simply stated, inspectors using this procedure assess the visibility and retroreflectivity of traffic signs as they approach the signs on the roadway during nighttime conditions. If the signs are bright enough to be detected and read, then they are ok as is. If the signs are deemed marginal, they should be scheduled for replacement. If some signs are not bright enough, they should be replaced as soon as possible.

Consistent Parameter Procedure Requirements

The following conditions must be met to properly assess the retroreflectivity of signs using the Consistent Parameters Procedure option of the Visual Inspection Method:

- ▶ Inspections must be conducted at night.
- ▶ Inspectors must be 60 years or older.
- ▶ Inspectors must conduct inspections from a sports utility vehicle (SUV) or pickup truck, model year 2000 or later.
- ▶ Inspectors must go through training. Training courses are available at many Local Technology Assistance Program (LTAP) centers. <http://www.ltapt2.org>.

Guidelines for Establishing an Inspection Protocol

Your agency should develop specific guidelines for conducting nighttime inspections. The content of these guidelines is up to you and your agency. However, in general, the following considerations should be taken into account.

- ▶ **Consistency of testing conditions.** Conduct inspections during consistent nighttime conditions whenever possible (e.g., always conduct inspections on clear nights, when there is no rain or fog). Keep the interior light of the inspection vehicle off. Use a pen light for recording the results of the inspection. Use at least three ratings: adequate, marginal, and fail.

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Right of Way Asset Data Collection

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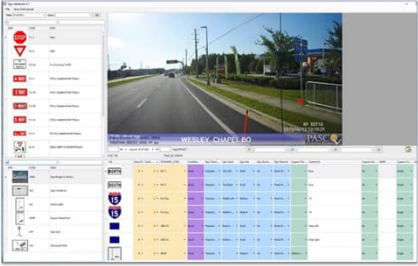
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SURVEY PHOTOS AND DETAILS



TAPCO's Traffic Signs

Complete with the entire Standard Highway Signs Library





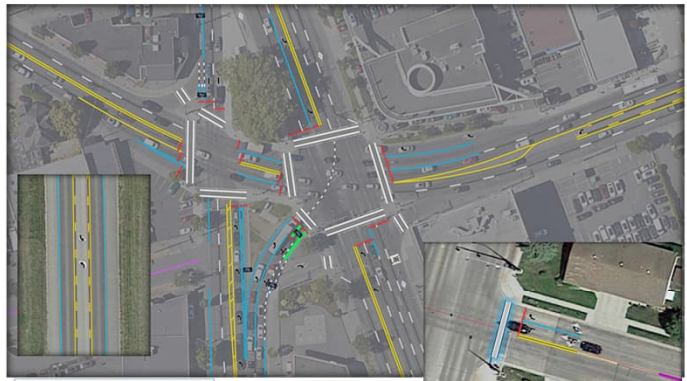
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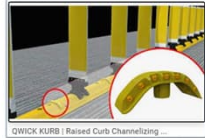

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 - *Hi-Visibility Cross Walk Angular Lines*
 - *Hi-Visibility Cross Walk with Horiz Lines*
 - *No Striping*
 - *Quick Curb*
 - *Raised reflective markers RMP*
 - *Stop Bar*
 - *White Dashed Single*
 - *White Short Dashed Single*
 - *White Solid Single*
 - *Yellow Dashed Double*
 - *Yellow Dashed Single*
 - *Yellow Short Double Widely Spaced*
 - *Yellow Solid Double*
 - *Yellow Solid Single*
 - *Yellow Solid/Dashed*
 - *Yield Bar*
- **Comments**

GIS LAYOUT AND SURVEY PHOTOS



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- ❖ **Retroreflectivity of signs**