CROSSROADS

Manage signs with inventories and inspections

Many local agencies integrate compliance into their operations gradually to spread replacement costs over several years and reduce the strain on tight budgets.

HOW ARE LOCAL governments stepping up to meet standards in the *Manual on Uniform Traffic Control Devices* (MUTCD)? They still need to comply with the federal standards when replacing signs despite a recent proposal to extend or eliminate retroreflectivity compliance deadlines. The answer for many local agencies in Wisconsin has been to integrate compliance into highway and street operations, gradually improving their management and assessment of signs. That way they can spread replacement costs over several years and reduce the strain on tight budgets. Public

officials from two Wisconsin cities share strategies here that are working for them.

Track resources

Preparing to meet the original deadline for minimum retroreflectivity in regulatory signs, the City of Brookfield in Waukesha County has been replacing those signs a group at a time since 2006. Brookfield Highway Superintendent Terry Starns handles that process and all traffic control maintenance activities with a computerized sign inventory using SIGNview software from Cartegraph. Any well-organized, up-to-date sign inventory—paper-based or computerized—is a good way to manage signs and meet the MUTCD requirements.

Brookfield activated its inventory in 2002. It contains all available information on sign location, sign type, material, size and type of post, condition

and age of sign. Last summer, the city rented a retroreflectometer to measure all signs older than eight years to fill in missing inventory data and support the regulatory sign replacement program.

Starns uses his SIGNview inventory to keep track of more than 6,200 signs and all the traffic signals and streetlights the city maintains. He records labor, equipment and materials costs in the program on a daily basis. It also helps the department generate weekly payroll data and annual GASB 34 reports.

"Entering key information only once is a big advantage of computer inventories like this, especially when it's compatible with the city's accounting software," Starns says. "Now we know what we have out there and everything about it. But being able to pull out specific data for planning or to use in day-to-day operations is very helpful."

He is pleased the city adopted the inventory tool when it did and credits support from top leadership for making it happen. "For something like this to be effective, you need a commitment from the top and we had that." The result for Brookfield is a database Starns describes as a real benefit to meeting the MUTCD and making sure the city's traffic control assets do their job.

"Being able to pull out specific data for planning or to use in day-to-day operations is very helpful."

Visualize crash data via Community Maps

"UNDERSTANDING the type of crashes on county roads over five years tells me a lot more than a gut feeling would about problems and where to concentrate our road improvement efforts."

Fond du Lac County Highway Engineer Paul Sponholz is referring to the benefits of diving into Community Maps earlier this year. After getting an account and setting up private work folders, he used the interactive online program to map injury and property damage crashes on county roads from 2006 through 2010.

In Lafayette County, Darlington Police Chief Jason King started using Community Maps this fall. He also mapped five years of crash data for a more complete picture of trouble spots and to document the case for possible improvements.

Community Maps is a joint project of the Wisconsin Transportation Information Center (TIC) and the Traffic Operations and Safety (TOPS) Lab, and sponsored by the Wisconsin Bureau of Transportation Safety.

In addition to a publicly accessible basemap of fatal crash locations, which TIC maintains, prospective local users can request advanced search and admin access. Those with admin access can manage crash data to produce spot maps, corridor maps and density maps that help guide project planning. Joni Graves, who directs the project at TIC, says proactive users like Sponholz and King "see the value of visualizing crash data to identify and prioritize possible traffic safety improvements."

Worth the effort

For Fond du Lac County, Sponholz notes that Community Maps really met a need for more decision-making information. "For the first time in my three years here, I've been able to map a significant portion of our crashes relatively quickly and easily with a few days work, something I've wanted to do for a long time," he says. "Now I can identify potential projects for general safety improvements or Highway Safety Improvement Program funds."

Sponholz mapped multiple-year data and saw that seemingly random incidents formed patterns. It confirmed his impression that the majority of crashes involved single-vehicle, run-off-the-road crashes on rural roads.

Two locations stood out. One was a winding county highway heavily traveled by area visitors. The other was a tight curve on a road that had no recovery area. In the case of the tight curve, Sponholz says the county paved the shoulders and installed chevrons as part of a planned resurfacing project to better delineate the curve. He anticipates more time to work with Community Maps with the construction season slowing down.

Local mapping options

Darlington's Chief King learned about Community Maps at a Traffic Safety Commission meeting and saw its potential. The department was using paper maps to identify the location of all crashes,

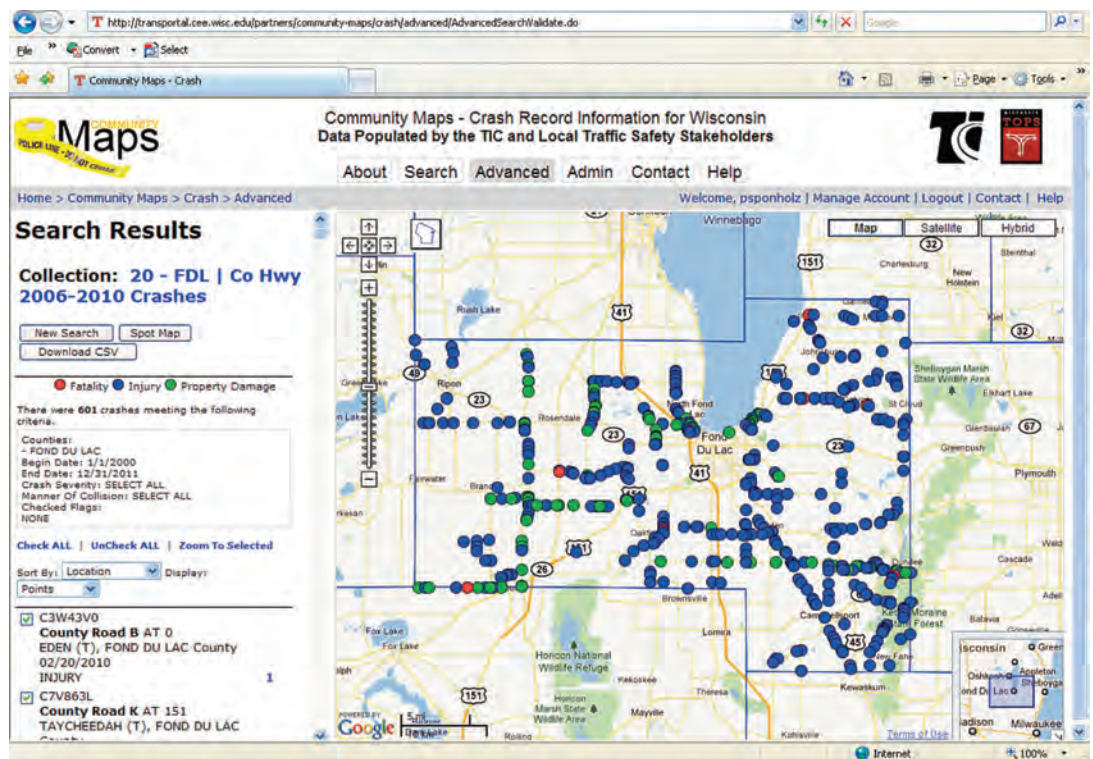*Community Maps search results display five years of injury and property damage crash locations mapped by Fond du Lac County's Paul Sponholz.*

Community Maps - Crash Record Information for Wisconsin
Data Populated by the TIC and Local Traffic Safety Stakeholders

About   Search   Advanced   Admin   Contact   Help

Welcome, psponholz | Manage Account | Logout | Contact | Help

Map   Satellite   Hybrid

Doc Nbr: 8598938
County: FOND DU LAC
Municipality: MARSHFIELD (T)
On: County Road Q
At: OAK RD
Date: 06/27/2005
Severity: injury (UNKOWN): 2 Injuries
Manner: NO COLL W/VEH IN TRANS
Result #:   493

Close up of a Fond du Lac County spot map (top) shows the location of single-vehicle crashes along a tight curve. The visual data helped the county prioritize cost-effective safety measures as part of a resurfacing project that included paving shoulders around the curve and installing chevrons, as seen in the photo above.

including "non-reportable" crashes not included in state data.

Graves populated a private work folder in Community Maps for him with five years of crash data, provided documentation and responded to questions. King used the program's "auto locate" and "plot crash" functions to produce maps he can share with the city's public works director and other city officials. Later the mapped data will be added to the publicly searchable map interface.

King says his initial Community Maps analysis identified several fender benders near the local high school. Not unusual perhaps, given periods of high traffic volume and a concentration of inexperienced drivers. He sees this as a chance to work with the school and maybe use the data to support a Safe Routes to School proposal.

"Adopting Community Maps comes at a good time for us because our public works department is making plans to change out traffic signs," King says. "Since the city is spending time and money on these changes, we're collaborating with public works to review the crash data and maps so that sign updates will take all safety issues into account."

Local management of crash data

Sponholz advises that other local road officials who want to try Community Maps "talk to Joni." Graves' experience with the program, which she began developing in 2005, makes her a valuable resource for prospective and current users of the program.

Frank Phillips, an engineer who assists the Town of Warren in St. Croix County, has been a safety consultant for several years. He recently contacted Graves to request WisTransPortal data and a Community Maps overview and was impressed by the amount of data that is available "if you know whom to ask."

Village of DeForest Police Officer Brian Johnson recently demonstrated his work with Community Maps for the Dane County Traffic Safety Commission. "I was pleasantly surprised, Community Maps is easier to use than I imagined, with minimal data entry." As for accuracy, he reports plotting the location of some crashes to a specific parking lot stall. The DeForest Police Department is enthusiastic about helping other Dane County agencies get on board. "We are all a team and glad to help," says Lt. Daniel Furseth.

Interested users can sample the basic search functionality in Community Maps by followiing the link on the TIC website. Contact Graves to request advanced access, user documentation or more information about using public and private work folders to map crash data. ■

"Community Maps is easier to use than I imagined, with minimal data entry."

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Manage signs with inventories and inspections

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Resources

Website of Minnesota Local Roads Research Board with information about sign retroreflectivity and management, including a toolkit and handbook that are good general resources for local governments in Wisconsin.
www.lrrb.org/

Link to producer of SIGN - view inventory software.
http://cartegraph.com/

Nighttime inspections

Another city phasing in an overhaul of its sign program to comply with the MUTCD is the Monroe County community of Sparta. In 2011, the city's Public Works Department focused on completing a GIS sign inventory so they could reconcile city ordinances with existing signage and enact a plan to meet new retroreflectivity standards.

Then Director of Public Works Jordan Skiff (now Director of Public Works for the City of Fond du Lac) recalls the in-house inventory Sparta did was an ideal task for an injured employee on limited duty who drove the streets to compile the sign information. Although time consuming, Skiff says the process gave the staff a strong familiarity with the number, location and condition of the signs they had.

"The most immediate benefit of the sign inventory was having current data on how many signs we needed to inspect for compliance with retroreflectivity standards," Skiff notes. Up-to-date inventory spreadsheet in hand, he enlisted the help of the city's retired Park and Recreation Director, Roger Amundson, to perform a nighttime inspection using the *consistent parameters* method. The MUTCD requires an inspector who is at least 60 years old to conduct these inspections.

"Roger was willing to ride around in a truck with me at night, identifying which signs were difficult to see," Skiff explains. "We inspected about a third of the city in one evening, finding only a few signs that did not meet minimum levels of retroreflectivity." That initial inspection and its results helped establish a process the city plans to complete this winter.

Skiff describes the consistent parameters method as very efficient. "Even though we had to drive each street twice—once in

> *Skiff describes the consistent parameters method as very efficient. "Even though we had to drive each street twice– once in each direction– we determined quickly whether a sign was a problem or not."*

each direction—we determined quickly whether a sign was a problem or not. Doing this with rented equipment would have meant devoting entire days to the work while we had the meter, finding an efficient way to reach up to each sign and even stopping to measure signs that looked brand new."

Fact sheet resource

This issue of *Crossroads* includes a new Wisconsin Transportation Bulletin on *Meeting Minimum Sign Retroreflectivity Standards.* This special four-page insert starts on page 5. It features details on the choice of accepted management and assessment methods for maintaining signs and tips for creating an inventory. This fact sheet resource helps local Wisconsin governments identify methods for monitoring the quality and effectiveness of existing signs and replacing them when they wear out. All local public agencies are responsible for meeting the standards for traffic control devices laid out in the MUTCD and finding an approach that fits their operations and resources. ■

Entry screen from the City of Brookfield's sign inventory using SIGNview software. Highway Division staff members record data on paper forms that match the fields on this screen. Administrative Assistant Linda Plicka then transfers the information to the primary database.

CROSSROADS EXTRA!!
4-page fact sheet insert
WTB #23
Published by the Wisconsin Transportation Information Center
WISCONSIN TRANSPORTATION BULLETIN — — — — — — — — — — —

Meeting Minimum Sign Retroreflectivity Standards

Local agencies are responsible for installation and maintenance of signs on local roads. The *Manual on Uniform Traffic Control Devices* (MUTCD) regulates traffic control devices for all public roads in the United States and provides guidance to agencies that manage sign inventories. Changes to the requirements for nighttime visibility of signs in MUTCD require local agencies to adopt appropriate sign management methods and meet specific minimum sign retroreflectivity standards.

Retroreflectivity refers to how a surface, like a highway sign or pavement marking, reflects or bounces light back to a source. The MUTCD always required that highway signs be clear and visible both day and night. Since it is impossible to judge the night brightness of signs during the day, the most practical ways to determine they meet requirements have been nighttime inspections and regular sign replacement. Until recently there have been no specific MUTCD standards for the level of reflectivity or the assessment and management methods agencies use to manage and maintain minimum sign retroreflectivity.

New Regulations and Deadline for Compliance

The updated MUTCD adopts specific standards for sign retroreflectivity that designate the minimum maintained retroreflectivity levels for each sign type and color. The new rules also require agencies and officials with road maintenance responsibilities to select and use an assessment or management method that helps them maintain sign retroreflectivity at or above the minimum level defined in the MUTCD.

This addition to the MUTCD means agencies must follow an approved method, or combination of methods, to assure adequate nighttime visibility of their street and highway signs. The standard recognizes that some signs occasionally fall below specific minimum levels of retroreflectivity.

The key is to adopt an approved method and fully implement it with the intent of bringing all signs into compliance.

The 2009 MUTCD set a standard for minimum retroreflectivity levels of traffic signs and established three deadlines to meet those minimums, including: 1) January 2012 to adopt an approved assessment or management method for meeting the standard, 2) January 2015 to bring regulatory, warning and post-mounted guide signs into compliance, and 3) January 2018 to bring overhead and street names signs into compliance. The FHWA proposed a major revision in August 2011 replacing these deadlines as follows:

> *Implementation and continued use of an assessment or management method that is designed to maintain regulatory and warning sign retroreflectivity at or above the established minimum levels, to be effective two years after the adoption of the revision.*

The public comment period for the proposed revision is closed and all comments are undergoing review as this Wisconsin Transportation Bulletin goes to press. It is important to note the revision does not change required minimum retroreflectivity levels for signs. Those levels remain a standard as adopted in the 2009 MUTCD. Road agencies are responsible for meeting the standards even though the proposed revision might nullify previously published deadline dates.

The Wisconsin Transportation Information Center publishes this fact sheet to guide local officials as they work to meet the minimum retroreflectivity standards for traffic signs.

What is Retroreflectivity?

Highway signs are made with sheeting that directly reflects light back to the headlights. This property of reflecting light back to its source is called retroreflectivity. Early sign

Retroreflective light returns to driver from headlight beam striking road sign.

materials used glass beads encapsulated in plastic. Current sheeting materials use tiny prisms to achieve retroreflectivity.

While these newer materials do a good job of returning light to the source, their effectiveness depends on the relative location of the headlights, the sign and the driver's eyes. Because a driver sits higher than the headlights, the amount of reflected light is reduced. For someone driving taller vehicles like vans, SUVs or commercial trucks, the increased distance between the headlights and the driver's eye reduces the reflected light even more.

Maintaining Night Visibility of Critical Signs a Requirement

Implementation and continued use of an assessment or management method designed to maintain retroreflectivity at or above the established minimum levels in regulatory and warning signs.

— Section 2A.08 of the 2009 MUTCD

The MUTCD bases retroreflectivity standards on experiments using older drivers to evaluate the visibility of traffic signs placed at proper mounting heights and offsets while driving at various speeds and in various vehicles. Besides following the recommended mounting height and offset, make sure the sign face is installed perpendicular to the road's centerline and the signpost is plumb.

Studies show that the use of color on a sign as either a background or a message results in different minimum levels of retroreflectivity. TABLE 1 indicates minimum retroreflectivity measurements for different sign colors.

Sign color and type	Minimum level of maintained retroreflectivity (cd/m^2)
WHITE on GREEN — EXIT, FREEWAY ENTRANCE — Ground mounted	**WHITE ≥ 120** Engineer Grade not allowed. **GREEN ≥ 15** Engineer Grade ≥ 7 allowed.
EXIT 158 B WEST, Marshfield Stevens Point 1/4 MILE — Overhead guide signs	**VARIES BY SHEETING TYPE**
BLACK on YELLOW or BLACK on ORANGE — Warning signs	**YELLOW / ORANGE ≥ 50** Signs 48″ or more and all bold symbol signs. Engineer Grade not allowed.
ROAD WORK AHEAD, END ROAD WORK — Warning in Work zone	**YELLOW / ORANGE ≥ 75** Signs less than 48″ except symbol signs. Engineer Grade not allowed.
WHITE on RED — STOP, YIELD, DO NOT ENTER — Stop, Yield, Wrong Way Do Not Enter, etc.	**WHITE ≥ 35** **RED ≥ 7** Contrast ratio of 3:1 or greater. (White retroreflectivity divided by red retroreflectivity)
BLACK on WHITE — SPEED LIMIT 55, ONE WAY, 10 — Speed Limit, One Way U.S. Highway, etc.	**WHITE ≥ 50**

TABLE 1. Simplified version of MUTCD Table 2A-3 shows sign types and minimum retroreflectivity levels.

Maintaining Signs a Necessity

Exposure to sunlight has an impact on the reflectivity of sign sheeting. Typical sign life depends on the orientation to the sun and the type of sign material. Manufacturers warrantee Engineer Grade sheeting for seven years and newer prismatic sign materials for 10 to 12 years or longer.

Objects that obscure signs, like overgrown vegetation or parked cars, also can affect visibility. It is important to pay attention to these obstructions when evaluating the effectiveness of a sign in the field and then take corrective action.

Compliance Methods

The MUTCD gives local agencies choices of methods to help them comply with the new sign retroreflectivity requirements. The methods fall into two main categories—assessment and management. Assessment methods involve making visual inspections or taking optical measurements of nighttime sign visibility. Management methods use information on sign age and sheeting life cycle to replace signs systematically. Agencies can choose an assessment method, a management method or a combination of these to meet the requirements.

☐ Assessment methods
  – visual assessment
  – measured sign retroreflectivity
☐ Management methods
  – expected sign life
  – blanket replacement
  – control signs

The new standards require agencies to implement an ongoing method for maintaining minimum retroreflectivity of regulatory and warning signs using one or several of these approved methods.

Assessment Methods

The MUTCD outlines two approaches to assess the retroreflectivity levels of existing signs and determine which need replacement. Routine testing by eye at night or with a meter that measures retroreflectivity give agencies data to use in a sign replacement program.

Visual Assessment

There are three visual assessment methods. All involve night inspection to determine which signs do not meet minimum retro-reflectivity levels and require replacement.

Visual nighttime inspection works best when done by two people, one person to drive and determine sign locations and the other to evaluate sign visibility and record inspection findings. The inspection team should drive the road in both directions to view signs as the driving public does. They should travel at normal highway speeds and use low headlight beams. The vehicle headlights should be in proper adjustment. Useful tools include a clipboard, an inventory list of existing signs and a penlight. It is a good practice to conduct night inspections every year if resources allow.

The inspectors should place each sign measured in one of three categories. GOOD condition indicates a sign with an acceptable level of night visibility. Replace POOR signs as soon as practical. Schedule MARGINAL signs for more frequent night inspection. Upgrading all MARGINAL signs is the ideal. If this is not feasible, schedule more frequent inspections. Inspectors also should identify any signs obstructed by vegetation or other objects and schedule them for correction.

The visual assessment methods that meet the MUTCD standards are:

Consistent parameters
- Use a van, pickup truck or SUV model year 2000 or newer as the inspection vehicle. These vehicle types have higher driver positions and newer headlight designs which replicate common vehicle configurations that produce poorer retroreflectivity performance.
- Use an inspector who is at least 60 years old.
- Identify if a sign is bright enough to give adequate time for an effective response from drivers. Using one inspector for this procedure creates a consistent approach to evaluating sign condition. Field tests confirm this method is conservative compared to actual meter measurement of sign retroreflectivity.

Calibration signs

- Use any vehicle type and any age inspector.
- Use a set of calibration signs that are at the minimum level of retroreflectivity.
- Select the calibration signs of each color using a retroreflectivity meter. Signs removed from service can be a source for calibration signs. Agencies also can use new Engineer Grade signs for this purpose, but these would produce more conservative inspection results.
- Position calibration signs consistent with normal sign mounting height and location.
- View calibration signs at normal highway speeds to establish a comparison for their subsequent inspection in the field.
- Return to the calibration sign site periodically to refresh the eye's calibration during the inspection process.
- Protect calibration signs when not in use so their retroreflectivity does not change over time.

Comparison panels

- Use any type of vehicle and any age of inspector.
- Obtain comparison panels (about 4" x 8" in size) of sign material in each color that meets minimum retroreflectivity levels. Cut comparison panels from signs no longer in service or from new Engineer Grade signs.
- Conduct a night inspection to identify GOOD, MARGINAL or POOR sign condition.
- Document signs rated GOOD; schedule replacements for signs rated POOR.
- Do additional evaluation of MARGINAL signs, attaching the matching color comparison panels to the sign. View the sign at a distance of 25 feet, holding a flashlight at eye level aimed at the sign. Mark for replacement any signs that do not appear to exceed the retroreflectivity of the comparison panels.
- Protect the comparison panels by storing them so that they are not exposed to light or dirt that can reduce retro-reflectivity over time.

Of the three visual inspections methods, the comparison panels approach requires the least amount of judgment, but it does involve additional detail work with the attachment of comparison panels to MARGINAL signs. Both the comparison and calibration methods require obtaining signs at the minimum retroreflectivity level to use for comparison.

Measured Sign Retroreflectivity

This assessment method removes the judgment required when using one of the visual assessment options, and it eliminates the need for night work, but it does require a retroreflectivity meter and an inspector well trained in its use. Purchasing a meter is a significant expense, but agencies can contract with an outside company to measure the retroreflectivity of all existing signs for them.

The steps in this method are:

- Measure the retroreflectivity of each sign along the road: take four meter readings for each color and average them to establish a sign's retroreflectivity level.
- Compare the measured average retroreflectivity level for each color to the minimum retroreflectivity values in Table 2A-3 of the MUTCD *(see simplified version on previous page)*.

Management Methods

Agencies that use management methods are able to meet minimum requirements without inspecting the retroreflectivity of each sign. These methods use industry knowledge of typical sign life or testing of representative sample signs to identify those that need replacement. Because this does not involve inspection of all signs, agencies may end up taking some signs out of service before they fall below minimum requirements or miss premature deterioration in other signs. Although management methods require significantly less field inspection time than assessment methods, a good sign program should include inspections to identify signs that are installed improperly, damaged, missing or obstructed by vegetation.

The three management methods are:

Expected Sign Life

- Replace signs at the end of their expected useful life.
- Establish expected useful sign life for each sheeting type and color.
- Use data from sign sheeting warranties, industry sheeting life studies or agency studies to establish sign life.
- Remove and replace signs when they reach the established useful life.
- Track when signs are due for replacement.
- Use a sign inventory to track sign replacement or mark installation dates on the back of signs to help track sign life.

Blanket Replacement

- Replace all signs in a specified area or all signs of a certain type on an established schedule. For example, replace all signs in a subdivision or replace all STOP signs in a jurisdiction.
- Establish a blanket replacement schedule based on expected sign life.

Control Signs

- Mount signs that include each sheeting type and color the agency uses in a test location or designate specific installed signs as test signs.
- Monitor sign retroreflectivity of test signs to determine the useful life of the each sheeting type and color. Establish a standard testing procedure using a retroreflectivity meter.
- Note installation dates and track age of all signs in the system with an inventory.

Combining Methods

The MUTCD allows a combination of assess-ment and management methods, which might be a good approach for many agencies.

One example is to use the consistent parameter assessment method to identify marginal signs and use a retroreflectivity meter to test them. Another example is to combine expected sign life for identifying older signs with a visual nighttime assessment to decide if specific signs require replacement.

An agency also can begin using one method and switch to another method later. An agency may start with an assessment method, for example, and then change to a management method after collecting reliable data on expected sign life.

Sign Sheeting Materials

Sign sheeting materials continue to evolve in the marketplace. For many years, Engineer Grade-type sheeting was the standard and many of these signs are still in use. More recently, manufacturers have introduced prismatic sign materials to increase sign visibility. Since their effective life span is longer than Engineer Grade, these more reflective materials are gaining in popularity.

Because the initial retroreflectivity values of Engineer Grade sheeting are at or below the minimum retroreflectivity values required for green and yellow signs, the new MUTCD prohibits using the material for those guide and warning signs. Agencies can choose Engineer Grade for red and white replacement signs but should recognize the material is only slightly above minimum retroreflectivity levels and has a short useful life. State and local agencies are using high-intensity prismatic material for most new signs as a result.

Agencies should stay informed about ongoing sign material developments and be prepared to compare the initial total cost—including installation—and the life expec-tancy of different sheetings types when selecting replacement signs. Considering the costs of installation, signs made from longer-

lasting materials can cost less over time. The exception is in locations where signs are stolen or damaged frequently.
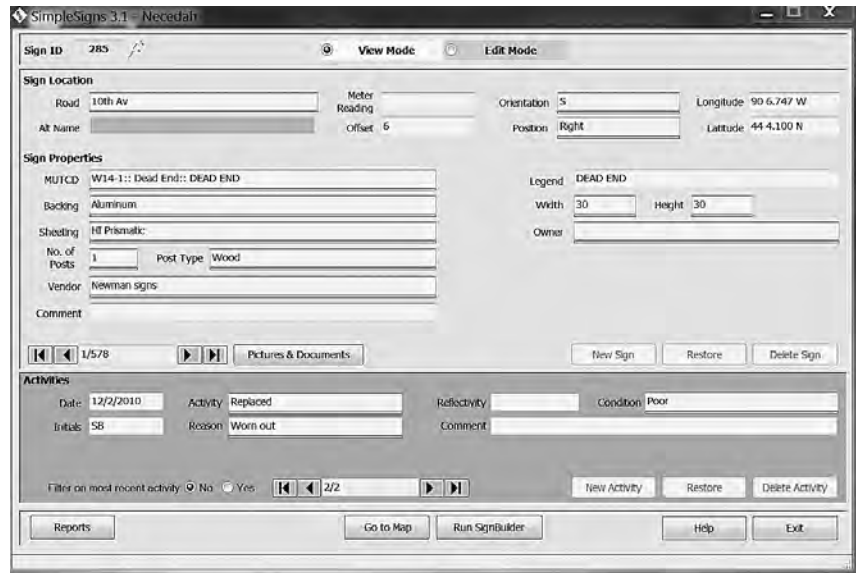
Create a Sign Inventory

A sign inventory is useful for meeting sign replacement requirements, budgeting mainte-nance and overall sign management. There are a growing number of commercial computer-based sign inventory systems. Other options that work for some agencies are computer spreadsheets, inventories on paper or record-ing data on stickers placed on sign backs.

The basic information in a sign inventory includes: sign location, height, offset, sign type, sheeting material, sign installation date and condition. Computer systems can use GPS data for sign location and mapping. A simpler approach for location is to use road name and mileage, cross street or address information. Gather data for an initial inventory by driving the road in each direction and recording the basic information on all existing signs. The safest approach is for two people to conduct this survey during the day.

Summary

Highway agencies are responsible for sign installation and maintenance programs that contribute to making the roads safe and accessible. Drivers need signs that are visible both day and night. While nighttime visibility is a long-established MUTCD standard, the 2009 update sets standards that define specific values for sign retroreflectivity. The MUTCD also identifies the methods highway agencies can follow to bring their signs into compliance with new minimum levels.

The variety of practical assessment and management methods that are available offer agencies options to match their capabilities and budget resources. As local governments gain knowledge and experience in managing their sign replacement program using one or a combination of methods, the process of keeping all signs in compliance with minimum retroreflectivity standards should become part of routine highway and public works operations.

Screen shot of a computerized sign inventory page.

FALL 2011
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WTB 23 – Minimum Sign Retroreflectivity Standards. Printed as an insert to **Crossroads** Fall 2011.

Reduce risks of drowsy driving

FEELING SLEEPY behind the wheel is a serious concern for plow operators and a potential liability for the local governments that employ them, especially during a long-lasting storm event. A tired driver is at greater risk of losing control and causing a crash.

Professor John Lee from the Department of Industrial and Systems Engineering in the College of Engineering at the University of Wisconsin–Madison researches driver distraction and notes that performance decreases substantially after someone operates a vehicle for 10 continuous hours. Doing so for 24 hours straight is the equivalent of driving under the influence. Lee says the general rule is that operators need to break at least every two hours to avoid driving drowsy.

A recent study commissioned by the U.S. Department of Transportation Federal Motor Carrier Safety Administration analyzed data on driver fatigue and crashes. Researchers compared commercial truck driver logs from one to two weeks preceding crash incidents to a random sample of logs for drivers not involved in crashes. They found that drivers experience increased crash odds starting in the sixth hour of driving. The odds continue to rise with a large increase in the eleventh hour. Rest breaks between driving events helped reduce crash odds.

A study in Australia also compared fatigue to alcohol impairment. Subjects kept awake for a 28-hour period and tested at intervals for hand–eye coordination showed the impairment of a person awake for 17 hours straight is equivalent to a blood alcohol level of 0.05 percent. After 24 hours, the impairment equaled 0.10 percent.

Managing fatigue a priority

Driving tired is preventable if highway and street departments make fatigue management a priority. A good starting point is to follow practices found in commercial fleet operations. A Transportation Research Board (TRB) synthesis report on commercial truck and bus safety found three key components in fatigue management programs:

1) Scheduling and dispatching practices that take sleep needs into account.

2) Attention to driver health and wellness that includes medical screening and counseling for sleep disorders.

3) Better awareness of fatigue signals through education and training.

Fatigue management resources developed for the commercial sector provide management practices and specific tools that identify risks of fatigue. A *Toolbox for Transit Operator Fatigue* developed through TRB's Transit Cooperative Research program targets bus fleet operations but the tips for healthy sleep, a self test for fatigue and sleep disorders, and other tools to prevent drowsy driving can apply to street and highway operations.

Scheduling strategies

During a snow event, local agencies may split crews into two shifts of 12 hours on and off, run crews for 16 hours or remain on-duty until the storm subsides. Operating until the job is done during a major storm can put a driver at a greater risk of an accident or crash caused by sleepiness. Tight budgets make it hard to add staff so the choices are to pull trucks and equipment off the road for rest or plan ahead with creative staffing alternatives. One common approach local agencies use is to recruit staff from other departments to work relief shifts. Training a group of relief drivers in advance is an effective way to counter the impact of a big storm.

Sauk County Safety Risk Manager Carl Gruber says his county's highway department usually schedules plow operators for 12-hour shifts during a snow
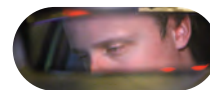
Driver performance decreases substantially after someone operates a vehicle for 10 continuous hours. Doing so for 24 hours straight is the equivalent of driving under the influence.

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Safety behind the wheel during extended snow events includes making sure plow operators are rested and able to stay alert throughout what can be a long shift to get the job done.

"We don't want anyone out on the road who could possibly be more of a hazard than the snow."

event and 16 hours at the most during a severe or sustained storm. He explains the approach depends on available manpower. To maximize the number of people ready to operate plow equipment, they train drivers to prepare for long shifts. This includes getting extra rest when they anticipate a storm, but also recognizing when they are too fatigued to run the equipment safely and request relief.

Consider sleep cycles

It helps to understand something about the mechanisms of sleep when setting schedules and policies. A person's internal body clock signals two times during a 24-hour period when the sleep drive is strong. For someone who works a daytime shift, these times likely fall between 2 to 4 AM and 1 to 3 PM.

Professor Lee saw the effects of these cycles in his recent research on drowsiness detection. "Even some of the well-rested drivers in the study became dangerously drowsy during the day and many more of them became drowsy

Brief breaks help fend off sleepiness by breaking the monotony of the driving task and getting the driver to walk and stretch to improve blood flow and reduce muscle fatigue.

TABLE 1
Signs of sleepiness

- Excessive yawning
- Difficulty staying in lane
- Hard time keeping eyes open
- Feeling irritable
- Hard time concentrating on driving task
- No memory of driving last few miles

TABLE 2
Tips for delaying fatigue

- Stay hydrated
- Circulate fresh air
- Keep cab temperature cool
- Maintain good posture
- Take stretch breaks

during late-night driving," he reports. "Everyone needs to be vigilant to fatigue."

Know your limits

"If someone is feeling tired, they know to ask for a break," Gruber notes. "We don't want anyone out on the road who could possibly be more of a hazard than the snow." Having a seasoned workforce that know their limits is a plus, he says. Experienced staff members help mentor newer employees on safe driving practices. Supervisors stay in regular contact with drivers during a storm event so they can check on people's alertness level.

TABLE 1 shows typical signs of sleepiness. Training employees and supervisors to recognize these signs in themselves and others, and making it clear the organization supports employees' decisions not to drive when drowsy are central to the success of efforts to reduce accident risks. Sauk County's policy requiring drivers to prepare for long shifts by getting adequate sleep reflects industry recommendations.

Once a driver becomes drowsy, the only solution is rest. See steps for delaying the onset of fatigue behind the wheel in TABLE 2.

Gruber says Sauk County's plow drivers make regular stops to reload salt, fuel up or clean their truck's windshield. These brief breaks help fend off sleepiness by breaking the monotony of the driving task and getting the driver to walk and stretch to improve blood flow and reduce muscle fatigue. "We also encourage them to drink plenty of fluids and I know some crew members plow with the windows open to let in fresh air."

Compliance via policies

Sauk County has a *Fitness for Duty* policy that requires employees to report for work physically and mentally able to do the job assigned and to comply with all safety requirements. Policies like this help local governments address safe practices behind the wheel and demonstrate their commitment to risk prevention.

They work best when employees are trained to follow them, supervisors are trained to recognize the symptoms of tiredness in crew members and the agency effectively implements the policy.

Solutions that fit

Snow season in Wisconsin puts major resource demands on local road and street operations. Plow operators, supervisors, mechanics and other crew members can find themselves stretched thin during major storms or a period of repeated snowfalls. When this happens, the risk of a drowsy operator having an accident or causing a crash increases.

Local road officials should develop fatigue management solutions that fit their operation. Even basic prevention techniques—like training employees to respond appropriately to the signs of drowsiness, promoting healthy sleep habits and scheduling manageable shifts—reduce the risks and liabilities associated with drowsy driving. ■

Resources

Hours of Service and Driver Fatigue: Driver Characteristics Research, Penn State University for the U.S. Department of Transportation Federal Motor Carrier Safety Administration, May 2011
www.fmcsa.dot.gov/facts-research/research-technology/report/HOS-Driver-Fatigue.pdf.

Effective Commercial Truck and Bus Safety Management Techniques: A Synthesis of Safety Practice, 2003, Transportation Research Board of the National Academies. Summary of commercial truck and bus safety management techniques includes information on fatigue management practices.
http://pubsindex.trb.org/view/2003/M/661879

Toolbox for Transit Operator Fatigue, 2002. Transportation Research Board of the National Academies. Documents the principles, techniques and strategies transit operators use to develop fatigue-mitigation plans. Includes a how-to section for designing, implementing and evaluating plans.
http://pubsindex.trb.org/view/2002/M/723711

Publications

Safety Edge Demonstration Day notebook from the October 2011 Every Day Counts program includes information on techniques for implementing Safety Edge.

FHWA Safety Edge brochure describes safety issues associated with pavement edge drop-off and explains Safety Edge construction.

AAA Foundation for Traffic Safety brochures:

▶ *Distractions in Everyday Driving*. Describes obvious and not-so-obvious distractions; offers tips and best practices for managing distractions.

▶ *How to Avoid Drowsy Driving*. Explores strategies for staying alert and knowing when to get off the road. Dispels common myths about driving tired. Includes checklists of danger signals for drowsiness and symptoms of sleep disorders.

▶ *Over the Edge and Back*. Explains actions necessary to recover a vehicle safely when one tire drops off a raised pavement edge.

Also available for free download or quantity order at:
www.aaafoundation.org/products/index.cfm?button=free

Web Sources

FHWA Sign Retroreflectivity Guidebook provides interactive online resource for local agencies selecting a sign assessment or management method. Includes Q&A that help identify the best method. Some copies available in print from TIC.
http://safety.fhwa.dot.gov/roadway_dept/night_visib/retrotoolkit/

FHWA site with links to the latest *Manual on Uniform Traffic Control Devices* standards publication and updates on proposed revisions to targeted compliance dates.
http://mutcd.fhwa.dot.gov/

Texas Department of Insurance, Division of Workers' Compensation offers *Driver Fatigue and Road Trance: A 5-Minute Safety Training Aid* HS01-014C (8-07).
www.tdi.texas.gov/pubs/tdipubs11.html#D

Fatigue, alcohol and performance impairment, 17 July 1997. Research by Drew Dawson and Kathryn Reid published in *Nature* summarizes results of a study tracking the driver performance of subjects kept awake over a 28-hour period. The Study compares the effect of tiredness on performance to that of excess alcohol consumption.
http://www.nature.com/nature/journal/v388/n6639/full/388235a0.html

Link to *An Evaluation of Emerging Driver Fatigue Detection Measures and Technologies*, Volpe National Transportation Systems Center for the U.S. Department of Transportation Federal Motor Carrier Safety Administration, June 2009. Final report on study of developments in vehicle-based operator alertness-monitoring technologies.
www.trb.org/Main/Blurbs/161904.aspx

National Sleep Foundation information on sleep cycles and how the internal body clock works.
www.sleepfoundation.org/article/sleep-topics/sleep-drive-and-your-body-clock

DVD/VHS/ Multimedia

Safety Edge thumb drives from FHWA contain research reports, presentations related to Safety Edge and other strategies for reduction of run-off-the-road crashes. Limited quantity available FREE from TIC.

Drive Safe! Public Risk Insurance Made Easy (PRIME), Division of Glatfelter Insurance Group, 2008, 15 minutes, DVD. Information on vehicle inspection, driver alertness, defensive driving and safe vehicle backing. Video focuses on municipal operations and is useful for new driver training or as a refresher for drivers of cars and light trucks.

Print copies of listed publications available free from TIC. Download or request items at Publications on TIC website. Video, CDs, and DVDs loaned free at county UW-Extension offices. Also see Video Catalog on TIC website.

TIC website
http://tic.engr.wisc.edu/

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Details, locations & registration forms sent to *Crossroads* recipients prior to each workshop. More information & online registration at *http://tic.engr.wisc.edu/workshops/listing.lasso*

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MAR 23	PEWAUKEE

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MAR 29	WAUKESHA
APR 3	EAU CLAIRE
APR 4	HAYWARD
APR 5	TOMAHAWK
APR 6	GREEN BAY

Gravel Road Maintenance

Review of maintenance methods unique to gravel roads. Locations subject to change. Fee: $60

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Save time and travel costs when you schedule training at your shop or office. It's convenient and courses can be tailored to your specific needs. On-site workshops let you train more people for the same cost or less, including staff from other municipal departments, nearby communities, or businesses you contract with. Contact TIC to book the program and date you want. On-site workshops include:

- Basic Surveying for Local Highway Departments
- Basic Work Zone Traffic Control
- Flagger Training

UW-Madison Seminars

Local government officials are eligible for a limited number of scholarships for these EPD courses held in Madison. Go to *http://epd.engr.wisc.edu* or call 800-462-0876.

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11-13 Improving Public Works Construction Inspection Skills M853

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