Title: REQUIREMENTS AND GUIDANCE FOR PAVEMENT MARKING OPERATIONS – REQUIRED INSTALLATION OF CARDS AND TRAVEL LANE AND SHOULDER WIDTH ADJUSTMENTS

Target Audience:
- Manufacturers (18)
- Local Govt. (31)
- Agencies (32)
- Surveyors (33)
- Consultants (34)
- Contractors (39)
- ___________( )

Approved:
/s/Richard W. Lee
Richard W. Lee, P.E.
Acting Deputy Chief Engineer, Design
9/6/13

ADMINISTRATIVE INFORMATION:
- Effective Date. This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of 1/9/2014.
- Superseded Issuances. This EI supersedes EI 10-030 “Rumble Strips - Centerline Audible Roadway Delineators (CARDS) - Guidance and Policy”.
- Disposition of Issued Materials: The revisions issued with this EI will be incorporated into a future update of Highway Design Manual (HDM) Chapter 11 Signs, Signals and Delineation.

PURPOSE: The purpose of this EI is to announce new requirements and guidance for pavement marking operations and for the installation of CARDS.

TECHNICAL INFORMATION: The requirements of this instruction apply to Department- and contractor-applied permanent pavement markings per EI 87-030 “Pavement Marking Policy.” This EI does not apply to interim (up to one year) or temporary (up to 14 day) pavement markings.

The requirements include widening select narrow travel lanes, widening select narrow shoulders, and include CARDS as part of permanent pavement marking operations and contracts on select highways, regardless of the pavement treatment.

Widening Narrow Travel Lanes:

To improve safety and provide for non-motorized traffic, striped travel lane widths along two-lane highways without on-street parking should be adjusted as follows unless a non-conforming feature explanation is provided in accordance with HDM Section 5.1. Note that pavement marking removal will be required where edge lines are adjusted. No design criteria or approvals are needed for these changes provided the road is a two lane highway, travel lanes widths will be 11’ (3.3 m) wide and the remaining paved shoulder will be at least 4’ (1.2 m) or wider for non-motorized transportation.

- On two-lane highways posted for 45 MPH or more with no median, two-way traffic volumes of at least 2,000 vpd, and 5’ (1.5 m) or wider shoulders, 10’ (3.0 m) travel lanes are to be restriped as 11’ (3.3 m) travel lanes.
- On two-lane highways posted for 45 MPH or more with no median, two-way traffic volumes of at least 2,000 vpd, and 6’ (1.8 m) or wider shoulders, 9’ (2.7 m) travel lanes are to be restriped as 11’ (3.3 m) travel lanes.

While lane widening will cause a slight decrease in the effective width of the clear area (which is measured from the edge line), those safety effects will be small in comparison to the safety benefits from
the systematic widening of the travel lanes as detailed in this EI. As it is not practical to revise the Department’s clear zone width commitment for every site where the travel lane is widened, no such revisions are required in conjunction with the restriping. Rather, this EI serves as the justification for those instances where potentially hazardous features that were previously beyond the clear zone will subsequently be within the repositioned clear zone. However, when a project arises where it would be appropriate to address the clear zone, designers should evaluate the clear area to determine whether the clear zone commitment needs to be reduced or the clear area expanded. The decisions should be appropriately documented.

Cross slopes are not critical design elements for 1R or maintenance projects. Where 1R paving (as defined in HDM Chapter 7) is performed prior to pavement marking operations, cross slopes should be adjusted (see preferences in HDM Chapter 3, Section 3.2.5) for the updated lane width so that the full lane width can benefit from superelevation.

Lane width changes to 3 or more lane highways (e.g., with two-way left turn lanes, passing lanes or climbing lanes) require site specific analysis and design criteria to determine widths. This work requires a 2R or more complex project in accordance with the NYSDOT HDM and Project Development Manual (PDM).

**Widening Narrow Shoulders:**

To improve safety and provide for non-motorized traffic, striped shoulder widths along two-lane highways should be adjusted as follows unless a non-conforming feature explanation is provided in accordance with HDM Section 5.1. Note that pavement marking removal will be required where edge lines are adjusted. No design criteria or approvals are needed for these changes provided the road is a two lane highway, travel lanes widths will be 11’ (3.3 m) wide and the remaining paved shoulder will be at least 4’ (1.2 m) or wider for non-motorized transportation.

- Where shoulders are less than 4’ (1.2 m) wide, posted speeds are 40 MPH or less, the highway is not part of the Qualifying Highways, and lane widths are 12’ (3.6 m) or wider, the lane widths are to be reduced to 11’ (3.3 m) and the shoulder width increased to improve space for non-motorized traffic.

Cross slopes are not critical design elements for 1R or maintenance projects. Where 1R paving (as defined in HDM Chapter 7) is performed prior to pavement marking operations, cross slopes may be adjusted (see preferences in HDM Chapter 3, Section 3.2.5) for the updated shoulder width.

Shoulder width changes to 3 or more lane highways (e.g., with two-way left turn lanes, passing lanes or climbing lanes) require site specific analysis and design criteria to determine widths. This work requires a 2R or more complex project in accordance with the NYSDOT HDM and Project Development Manual (PDM).

**Installation of CARDs Prior to Installation of Permanent Markings:**

Preventing lane departure crashes, including head-on and sideswipe collisions, is an important part of New York’s Strategic Highway Safety Plan. In New York State, approximately 120 deaths and 3,500
injuries occur each year from non-intersection head-on and opposite-direction sideswipe crashes, and at least one in five crashes has distracted driving listed as a contributing factor.

Rumble strips save lives and prevent serious injuries by alerting drivers with an audible warning (rumbling sound) that they are leaving their driving lane. Centerline rumble strips also cause a physical vibration to vehicles when they begin to stray into oncoming traffic lanes. They help combat distracted driving and can alert drivers to lane limits when weather conditions reduce driver visibility or roads are covered with snow. Centerline rumble strips (a.k.a. centerline audible roadway delineators (CARDs)) have been found to be a particularly effective safety device on undivided high-speed roads where there is no median or room for barriers to separate opposing lanes of traffic. They are effective in both rural and urban environments. The Department expects CARDs to:

- Be safe for motorcyclists. CARDs were tested for motorcyclist safety by MnDOT as part of K.W. Miller’s, “Effects of Centerline Rumble Strips on Non-Conventional Vehicles,” 2008, and found to “add no measurable risk to motorcyclists.”
- Be safe for bicyclists. After an extensive search, the Department has not found any evidence that milled-in rumble strips adversely impact bicyclists. Furthermore, the centerline location essentially precludes bicyclists riding along them.
- Have minimal noise impacts. To help reduce noise impacts, CARDs are located under the centerline markings and are only 0.375” (10 mm) deep. Compared to freeway rumble strips (MIARDs), CARDs are 12” (300 mm) wide, instead of 16” (400 mm) wide, and spaced out 24” (600 mm) on center, instead of 12” (300 mm) on center. CARDs are also discontinued before intersections, major driveways, crosswalks, left turn lanes, and concrete bridge decks.
- Help prevent head-on, sideswipe and opposite direction run-off-the-road collisions. Installation of centerline rumble strips on 6% of the total highway miles in the state (7,040 miles of state highway) is expected to prevent over 20 deaths and over 250 serious injuries per year.
- Have a benefit/cost ratio of up to 75:1.
- Be relatively fast to install.
- Improve the visibility of centerline pavement markings, particularly in wet-night conditions.
- Extend the service life of centerline pavement markings.

Policy:
- CARDs are required in all D Contract paving work on CARD-eligible highway segments.
- Where VPP projects let by OGS will repave CARD-eligible highway segments, CARDs are to be implemented no later than the end of the following construction season.
- CARDs are to be milled prior to placing permanent (paint or durable) pavement markings on CARD-eligible highway segments where the pavement surface score is 7 or better (i.e., there is no minimum pavement treatment criteria). However, until the 1/5/2017 letting, Regions installing CARDs on 50% of their eligible highways by 3/31/2017 in accordance with the 2011 Capital Program Update (CPU) instructions are not required to install CARDs when placing pavement markings on sections paved prior to 4/1/2013.
- CARDs are not required for limited- or single-purpose projects such as guide rail, joint sealing, bridge maintenance, signal projects, ADA projects, or ditch maintenance.

CARD-Eligible Highway Sections:
- **Pavement:** Pavement surface score is 7 or better.
- **Median:** There is no raised median, two-way left-turn lane (TWLTL), or median barrier. CARDs are appropriate for flush medians.

- **Length:** The total quantity of CARDs in a project is 1,500 feet (500 m) or more. Because of the cost of mobilizing the equipment to mill in the CARDs, projects that would result in the total placement of less than 1,500 feet (500 m) may be exempted.

- **Speed:** The posted speed is 45 mph or greater. The likelihood of a severe injury or fatality increases dramatically in collisions of 45 mph (70 km/h) or greater.

- **Volume:** A current AADT of 2,000 vpd or more. The primary benefit of CARDs is to reduce the incidence of head-on and opposite direction sideswipe collisions. As traffic volumes decrease, the likelihood of such collisions decreases, with or without the use of CARDs.

- **Roadway Width:** The combined width of the lane(s) and shoulder, in each direction, must be at least 13 ft (3.9 m).

### Scoping Stage:
- **Project Costs:** Cost impacts are expected to be minor overall. However, on paving projects where they are used, they may constitute as much as a 1-5% increase in the project cost.

- **Pavement Treatment:** Where 1R paving (as defined in HDM Chapter 7) is performed, a 1” (25 mm) or thicker pavement is preferred. However, CARDs have been successfully milled into thin surface treatments including 0.75” (19 mm) top course, chip seal, microsurfacing and as part of CARD-only contracts.

- **CARD Only Contracts:** CARDs are encouraged to be installed as stand-alone projects on existing pavements that are in good or fair condition and meet the implementation criteria below, especially where a head-on or sideswipe crash potential is noted.

- **Funding:** Dedicated CARD projects are 100% HSIP fund eligible, including: any centerline joint repair; work zone traffic control; temporary, interim and permanent pavement marking over the CARDs; mobilization; etc. CARD and the pavement markings over the CARDs are 100% HSIP fund eligible as a separate share in other projects.

### Design Stage:
- **Plans:** The plans should include a Table of Centerline Rumble Strips indicating the starting and ending stations. Gaps and exclusions 100’ (30 m) or more in length should be identified in the table. Gaps and exclusions under 100’ (30 m) in length are paid for under item 649.11 and do not need to be detailed in the table. Gaps and exclusions under 100’ (30 m) in length are not to be deducted from the amount paid for under item 649.11.

- **Dimensions and Location:** Refer to the 649 Standard Sheets.

- **Field Evaluation:** Any pavement that has a score of 7 or less and is 5 years old or older, requires a Regional field evaluation before CARDs are specified for the location. For segments where centerline joint is not adequate for placing CARDs and a repaving project is not scheduled within 3 years for that location, the following work is required prior to the installation of CARDs:
  - Mill out a 2” (50 mm) deep and 2’ (0.6 m) wide area, centered on the centerline joint.
  - Clean the milled areas to the satisfaction of the engineer.
  - Tack coat all milled and vertical surfaces using Item 407.0103, Straight Tack Coat.
  - Place Item 402.098302, 9.5 F3 Top Coarse HMA, 80 Series Compaction.
  - Allow the repair to cure a minimum of 24 hours before installing the CARDs.

- **Fog Sealing:** Longitudinal joints are the weakest part of the pavement with generally lower
pavement density which typically equates to higher porosity. Milling across the joint may exacerbate the longitudinal joint problems that already occur. The Materials Bureau is experimenting with fog sealing to improve the centerline joint durability, with and without CARDs. Item 407.01110004 “SEALING CENTERLINE AUDIBLE ROADWAY DELINEATORS (CARDS)” is a Region 4 special specification that requires PIN approval. Once enough data is collected, information on the effectiveness of fog sealing will be shared and any necessary guidance will be provided to all Regions.

- **Project Coordination:** Where Department forces will provide the pavement markings, the contractor should install interim pavement markings after milling and a note should be added to the CARD contract requiring scheduling of the Contractor’s milling so that Department forces can apply the permanent markings within 3 months of the interim pavement marking installation.

- **Public Outreach:** In areas near residential neighborhoods and in urban areas, public outreach is recommended to help gain public acceptance of CARDs. A brochure to help inform the public on the benefits of CARDs is posted on the Department’s Internet webpage under Safety, and CARDs. A press release from the Commissioner was issued on 5/22/2012.

**Construction Stage:**

- **Gaps:** Prior to milling, the Contractor shall obtain EIC approval on where CARDs are to be installed and where required gaps are to be included. Refer to the 649 Standard Sheets.

- **Reporting:** Project managers should e-mail the location of new CARD installations to the Regional Traffic Office so the location may be entered into the Project Support System (PSS) or the Post Implementation Evaluation System (PIES) for evaluation.

**TRANSMITTED MATERIALS:** No materials are transmitted with this EI. However, links to the Department’s Standard Specifications and Standard Sheets can be found on the page at the following link:
https://www.dot.ny.gov/publications

**BACKGROUND:**

**Widening Narrow Travel Lanes:**

Based on the highway sufficiency data, CARD-eligible New York State highways include over 317 centerline miles (510 km) with 10’ (3.0 m) travel lanes and 5’ (1.5 m) or wider shoulders. These highways also include over 11 centerline miles (18 km) with 9’ (2.7 m) travel lanes and 6’ (1.8 m) or wider shoulders. Although the NYS Vehicle and Traffic Law Section 385 specifies an 8.5’ (2.6 m) maximum vehicle width, safety devices such as bumpers, side lights, and mirrors can extend out beyond the 8.5’ (2.6 m) width. Many large trucks take up approximately 11’ (3.3 m) of overall width. As speed increases, the offset between opposing traffic increases to avoid impacts. On high-speed highways with narrow travel lanes, traffic must travel along part of the shoulder, wearing off the edge line (fog line), in order to provide a reasonable offset to opposing traffic and avoid crashes.

While moving the edge line may place a portion of the shoulder within the travelled way, normal pavement striping practice is to avoid placing the stripe on a longitudinal seam and it is relatively common for the pavement markings to be on the shoulder side of the longitudinal pavement joint. The lane width changes are not anticipated to impact the pavement shoulder joint and should increase the edge line service life and visibility.
As documented in FHWA-RD-99-207 *Prediction of the Expected Safety Performance of Rural Two-Lane Highways* and the AASHTO *Highway Safety Manual*, there are substantial safety benefits of 11’ (3.3 m) and 12’ (3.6 m) travel lanes compared to 9’ (2.7 m) and 10’ (3.0 m) travel lanes in high-speed areas. For highways with over 2,000 vpd, changing a 10’ (3.0 m) lane and 5’ (1.5 m) shoulder section to an 11’ (3.3 m) lane and 4’ (1.2 m) shoulder section will reduce run-off-the-road and sideswipe crashes by nearly 20%. There is a nearly 40% reduction in these crashes when 9’ (2.7 m) lanes with 6’ (1.8 m) shoulder are widened to 11’ (3.3 m) lanes and 4’ (1.2 m) shoulders.

The restriping of narrow lane widths where shoulders are 5’ (1.5 m) or wider on CARD-eligible highways helps: provide adequate room for motor vehicles; reduces nuisance noise from incidental CARD overrides; and helps improve the longevity of the edge line while providing a minimum 4’ (1.2 m) width for non-motorized transportation. The estimated B/C ratio, including removing old edge lines, is over 23:1.

**Widening Narrow Shoulders:**

Based on the highway sufficiency data, two-lane New York State highways with posted speeds of 40 mph or less include over 215 centerline miles (346 km) with 12’ (3.6 m) or greater travel lanes and shoulders less than 4’ (1.2 m) wide. Approximately half of this mileage has curb or gutters. Reducing wide travel lanes to 11’ (3.3 m) on low-speed highways to widen narrow shoulders will help promote non-motorized travel in accordance with the NYS Complete Streets Law. As documented in FHWA-RD-99-207 *Prediction of the Expected Safety Performance of Rural Two-Lane Highways* and the AASHTO *Highway Safety Manual*, there safety is improved by adding to a narrow shoulder by reducing a 12’ (3.6 m) travel lane to an 11’ (3.3 m) lane. The travel lane reduction to 11’ increases crashes by up to 5%, which is more than offset by increasing the shoulder width to 4’ (1.2 m), which provides a crash reduction of up to 35%, depending on the traffic volume and the width of the old shoulder. The estimated B/C ratio, including removing old edge lines, is over 23:1.

**Installation of CARDS Prior to Installation of Permanent Markings:**

In New York State, there are about 120 deaths and 3,500 injuries from head-on and opposite direction sideswipe crashes each year. Nationwide, about one in five non-intersection fatal crashes involves two vehicles crashing head-on. Of these, 75% occur on rural roads. For all roads, one-third of head-on crashes involve vehicles “negotiating a curve” and two-thirds are related to vehicles “going straight.” Where they are used, centerline rumble strips have the potential to significantly reduce these types of collisions, with some studies showing up to a 64% reduction in these types of accidents. These kinds of reductions would save many lives and prevent scores of severe injuries.

For over 10 years, the Department has utilized rumble strips on the shoulders of freeways, just outside the edge lines. NYSDOT’s installation of those rumble strips has thus far helped achieve a significant reduction in the number of interstate run-off-the-road crashes. Nationally, other states have used centerline audible roadway delineators in an attempt to reduce the number of head-on collisions due to drivers drifting across centerlines. Their results were typically very positive. NYSDOT piloted installations of centerline rumble strips at spot locations (6.1 centerline miles (9.8 km) total) to gain some firsthand experience with installation methods for centerline rumble strips and develop a NYSDOT specification. A combined before and after Safety Information Management System (SIMS) analysis
showed a reduction in fatal crashes (from 3 to 1). By themselves, these test sites are far too limited to rely on solely for a statewide policy. In addition, NYSDOT relied on:

- A 2005 NCHRP Synthesis 339 (data from the Insurance Institute for Highway Safety study on centerline rumble strips in September 2003), which found that head-on and opposite direction sideswipe injury crashes were reduced by an estimated 25% at sites treated with centerline rumble strips or stripes. This early study concluded that centerline rumble strips/stripes provide a crash reduction factor of 14% of all crashes, and 15% of injury crashes, on rural two-lane roads.
- A 2009 NCHRP Report 641 “Guidance for the Design and Application of Shoulder and Centerline Rumble Strips,” which supports the use of centerline rumble strips as an extremely cost-effective collision countermeasure. Based on this more recent and complete study, fatal and injury crashes in urban areas were reduced an average of 64%. Fatal and injury crashes in rural areas were reduced an average of 44%.
- The experiences of 25 other states, which cumulatively have tens of thousands of miles of centerline rumble strips. For example, Pennsylvania has over 3,200 miles (5,100 km) of centerline rumble strips and has reduced fatal head on crashes by nearly 50%, saving approximately 150 lives per year. Washington State has over 2,000 miles (3,200 km) of centerline rumble strips and has reduced fatal and serious injury cross over and side swipe crashes by 57%.
- The recommendations and encouragement of FHWA, which considers centerline rumble strips, a proven safety measure that will save lives, consistent with the accommodation of cycling.

NYSDOT prepared a systematic crash analysis, as recommended by AASHTO, FHWA and NCHRP Report “Alternative Strategies for Safety Improvements,” January 2010. The analysis, which has been reviewed and endorsed by FHWA, concludes that centerline rumble strips have a benefit to cost ratio of over 75:1, and are anticipated to save over 20 lives and prevent over 250 serious injury crashes each year.

Based on the lack of any significant technical problems, and in light of the positive safety experience in other states, plus the strong endorsement from FHWA, the Department decided to begin using CARDs in 2010 as a preferred treatment. Additional information is available on the FHWA website at: [http://www.fhwa.dot.gov/crt/lifecycle/rumblestrips.cfm](http://www.fhwa.dot.gov/crt/lifecycle/rumblestrips.cfm)

While EI 10-030 required CARDs on eligible highways with 1.5” (40 mm) or more of paving, many highways eligible for CARDs may not be paved for many years and the use of 0.75” (19 mm) pavement overlays has increased substantially. Since pavement marking is required after milling CARDs, this EI adds the requirement to include CARDs as part of permanent pavement marking operations and contracts to help reduce severe crashes on New York State highways. However, until the 1/5/2017 letting, Regions installing CARDs on 50% of their eligible highways by 3/31/2017 in accordance with the 2011 CPU instructions are not required to install CARDs when placing pavement markings on sections paved prior to 4/1/2013. Eligible highway segments paved after 4/1/2013 require CARDs.

CARDs have been engineered to minimize pavement damage and can be milled into thin overlays, which have smaller aggregate sizes and can be milled more cleanly. A pavement surface score of 7 or better was chosen to minimize locations with existing centerline joint damage since CARDs may have less benefit at these locations. Michigan DOT is placing 5,400 miles (8,700 km) of centerline rumble strips. Their interim report states that the installation of centerline rumble strips on existing pavements “did not create any adverse impact on the short-term pavement performance.” The Office of Technical Services
will continue monitoring pavement performance to identify any positive or negative effects of CARD installations.

REFERENCES:


CONTACT: Direct questions from Operations regarding this issuance to Robert Limoges, P.E. of the Safety Programs Management and Coordination Bureau at (518) 457-2452 or via e-mail at Robert.Limoges@dot.ny.gov. Direct questions on materials to Russell Thielke, P.E. of the Materials Bureau at (518) 457-4585 or via e-mail at Russell.Thielke@dot.ny.gov. Direct all other questions to Richard D. Wilder, P.E. of the Design Services Bureau at (518) 457-5922 or via e-mail at Rick.Wilder@dot.ny.gov.