U.S. Department of
Transportation

Federal Railroad Administration

Use of Traffic Channelization Devices at Highway-Rail Grade Crossings

Office of Research
and Development
Washington, DC 20590

Safety of Highway Railroad Grade Crossings

DOT/FRA/ORD – 12/11

Final Report
August 2012

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 2012	Technical Report July 2008 – September 2009

4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
Use of Traffic Channelization Devices at Highway-Rail Grade Crossings	RR97A1/FG274
6. AUTHOR(S) Suzanne M. Horton	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Department of Transportation Research and Innovative Technology Administration John A. Volpe National Transportation Systems Center Cambridge, MA 02142	8. PERFORMING ORGANIZATION REPORT NUMBER DOT-VNTSC-FRA-09-13
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Department of Transportation Federal Railroad Administration Office of Research and Development 1200 New Jersey Avenue, SE Washington, DC 20590	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Safety of Highway-Railroad Grade Crossings series
Program Manager: Tarek Omar. D.Sc.

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE
This document is available to the public through the FRA Web site at http://www.fra.dot.gov.	

13. ABSTRACT (Maximum 200 words)

Traffic channelization devices have found new application at highway-rail grade crossings with active warning devices. Numerous studies conducted at locations where they have been installed show positive changes in unsafe driver behavior as a result of the treatments. When meeting certain requirements, traffic channelization devices and median barriers are an approved supplemental safety measure for the establishment of quiet zones. Traffic channelization devices are low cost and this makes them an attractive option for improving safety at highway-rail grade crossings.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Highway-rail grade crossing, traffic channelization devices, median barriers, safety	27
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

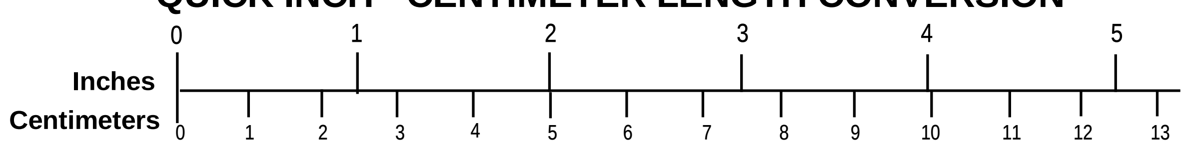
VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSIO

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286

Updated 6/17/98

Acknowledgments

The U.S. Department of Transportation (USDOT) Federal Railroad Administration's (FRA) Office of Research and Development sponsored the work leading to this report. The author would like to thank Sam Alibrahim, P.E., Chief of the Signals, Train Control, and Communications Division, FRA; and Leonard Allen, Program Manager, Signals, Train Control, and Communications Division, FRA, for their guidance and direction in developing this report.

The author would also like to acknowledge Marco daSilva, Highway-Rail Grade Crossing and Trespass Safety Research Program Manager, Systems Safety and Engineering Division, USDOT Research and Innovative Technology Administration's John A. Volpe National Transportation Systems (Volpe Center); Anya A. Carroll, Principal Investigator of Surface Transportation Programs, Center of Innovation for Physical Infrastructure Systems, Volpe Center; John McGuiggin, P.E., (former) Chief of the Systems Safety and Engineering Division, Volpe Center; and Glenn Goulet, Chief of the Infrastructure and Facility Engineering Division, Volpe Center, for their leadership and direction. Erica Squillacioti, Systems Safety and Engineering Division, Volpe Center, provided technical support.

Special thanks are given to Paul Worley, Director of Engineering and Safety, North Carolina Department of Transportation Rail Division, for contributing photographs of traffic channelization device installations at highway-rail grade crossings.

Contents

Illustrations

Executive Summary

Traffic channelization devices have found new application as effective safety measures at highway-rail grade crossings. The installation of traffic channelization devices at crossings with active warning systems (i.e., flashing lights and/or gate arms) provides a visual and physical barrier to deter motorists from entering the opposing traffic lane to circumvent the gate arms. Deterring such risky driver behavior creates a safer highway-rail grade crossing environment.

Different traffic channelization options are available. Some configurations are intended to be permanent fixtures and others are temporary. Each option has its advantages, based on the roadway design, the amount of funding available for the project, the community's needs and wishes, and traffic patterns. Decisions on whether to install median barriers at a crossing should be made using professional traffic engineering judgment and evaluation.

As the number of installations of traffic channelization devices at highway-rail grade crossings has increased, studies have been conducted to determine the effectiveness of these crossing treatments in reducing unsafe driver behaviors. These studies have shown conclusively that unsafe driver behavior changes appreciably when median barriers are installed at the crossings.

One of the most common uses of traffic channelization devices at highway-rail grade crossings is for crossings at locations within a designated quiet zone. The Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings (Title 49, Code of Federal Regulations (49 CFR), Parts 222 and 229) permits the use of traffic channelization devices or non-traversable curbs that meet specific requirements as supplemental safety measures (SSM). The median barriers or channelization devices must extend 100 feet (ft) from the crossing gate arm, or, if an intersection is within 100 ft of the crossing, the channelization device must extend 60 ft. The Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings states that channelization devices have an effectiveness rating of 0.75, and non-traversable curbs have an effectiveness rating of 0.80. The effectiveness rating is the reduction in likelihood of a collision at the crossing as the result of the SSM. Thus, a traffic channelization device that is used as an SSM will reduce the risk of a collision at that crossing. The Final Rule also permits the use of channelization devices to be applied as an alternative safety measure within quiet zones with less than 60-ft clearance. Alternative safety measures include SSMs that do not fully comply with all the rule's requirements. The benefits of installing channelization less than 60 ft in length have not been quantified.

Prior to installation of a traffic channelization device, an engineering analysis of roadway usage should be conducted to ensure that the installation does not result in unsafe conditions. Such an analysis allows for the most appropriate safety improvement to be identified for each crossing. Traffic channelization devices are considered to be a low-cost improvement that have effectively changed unsafe behavior by drivers at highway-rail grade crossings.

1. Introduction

Traffic channelization devices have long been used on highways to separate vehicular traffic or to facilitate smooth traffic flow. These devices are now also being used in new applications as safety measures at highway-rail grade crossings. Since 1994, collisions at highway-rail grade crossings have been reduced by over 60 percent. However, in 2011, there were 265 fatalities in 1,967 highway-rail grade crossing collisions [1]. Eliminating these incidents altogether continues to pose a challenge. Studies on driver behavior at grade crossings indicate that there is a strong correlation between violations of the crossing warning devices and collisions between trains and motor vehicles. Deterring the risky behavior of driving around a lowered gate arm makes the grade crossing a safer environment.

The U.S. Department of Transportation's (USDOT) Federal Railroad Administration (FRA) supports the use of traffic channelization devices at highway-rail grade crossings with active warning devices, where feasible. In 2008, the FRA Office of Safety issued the brochure *Guidance on the Use of Traffic Channelizing Devices at Highway-Rail Grade Crossings* [2]. The brochure was intended to assist in the selection of the appropriate traffic control device. It has been distributed on the FRA website and at rail conferences with the hope of encouraging traffic engineers to utilize traffic channelization treatments at grade crossings.

One of the most appealing aspects of using traffic channelization devices at highway-rail grade crossings is the cost. The implementation of a mountable curb with upright panels, such as the one shown in Figure 1, costs approximately $14,000. This cost, compared to the cost of outfitting a crossing with a wayside horn ($100,000+) or four-quadrant gates ($250,000), makes the traffic channelization device a very attractive option [3]. Median barriers are also a low-cost and highly effective means of reducing grade crossing collisions.

The most common application of median barriers and traffic channelization devices at grade crossings has been at crossings within a quiet zone. The Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings requires SSMs to reduce the risk at a crossing to a prescribed level. On the list of approved SSMs is a median barrier or other traffic channelization device of at least 60 ft. As more communities seek to establish quiet zones, the use of median barriers and traffic channelizing devices is expected to increase.

This document will provide information about the use of traffic channelization devices at highway-rail grade crossings. Within the text, the terms median barrier and traffic channelization device are used interchangeably.

Figure 1. Traffic Channelization Device Installation at Highway-Rail Grade Crossing (*photo courtesy of NCDOT*)

2. Traffic Channelization Options

The USDOT Federal Highway Administration (FHWA) and FRA have previously issued guidance on the types of traffic channelization devices that can be installed at grade crossings. Complete information on these types of treatments is available in the USDOT FHWA Highway-Rail Grade Crossing Technical Working Group's *Guidance on Traffic Control Devices at Highway-Rail Grade Crossings* [4] or USDOT FRA's *Guidance on the Use of Traffic Channelizing Devices at Highway-Rail Grade Crossings* [2]. Below is summary information about the potential use of traffic channelization devices available for installation at grade crossings.

Wide Raised Medians

A wide raised median is the most aesthetically pleasing option because it provides the opportunity to include landscaping in its design. Although it is not a barrier, it can be an effective deterrent against violations of the active crossing warning devices. Wide raised medians are durable enough to withstand snow plows, which is a concern in colder climates. The landscaping, however, can increase maintenance costs, and installation may require excavation and cutting of the roadway, which potentially increases costs. Figure 2 shows a wide raised median installation in North Carolina.

Figure 2. Wide Raised Median: Southeast High-Speed Rail Corridor, NC

Barrier Wall Systems

The barrier wall system is a concrete barrier similar to a Jersey barrier installation commonly used on divided highways. One advantage to this type of traffic channelization device is that it is the most effective deterrent against circumventing lowered gates. Another advantage is that the concrete wall is very durable. However, the installation of a barrier wall requires a wide section between the roadway lanes and this can make it difficult for vehicles, such as emergency vehicles, to make U-turns; it can also present problems with sight distance for drivers at the crossing.

Non-mountable Curb Islands

The non-mountable curb island is usually 6–9 inches (in) high and 2-ft wide. They are designed such that common roadway vehicles cannot traverse the island. The height of this device does lead to concerns about increased crash risk and severity of motor vehicle accidents along the roadway. Therefore, the design and installation of such a treatment must be carefully considered when installing a non-mountable curb island. Retroreflective markings are recommended to increase the curb's visibility in low-light conditions.

Mountable Raised Curb Systems

The mountable raised curb system is the most cost effective traffic channelization device installation. The curb itself is generally less than 6 in high and 12 in wide. The installation has minimal impact on the existing roadway and can be removed if necessary. Raised vertical panels are typically installed with this system. The panels provide a visual deterrent to motorists intent on circumventing a lowered gate. The panels are commonly made of a durable polymer and are reboundable; they also permit vehicles to cross over them. Because vehicles can cross over these curbs, this system requires regular maintenance to replace damaged vertical panels. Figure 3 is an example of a mountable raised curb installation.

Figure 3. Mountable Raised Curb System with Vertical Panels (*photo courtesy of NCDOT*)

Traffic Calming Devices

FHWA defines traffic calming devices as physical measures that reduce the effects of aggressive motor vehicle use and make the roadway a friendlier environment for nonmotorized vehicles or users. Traffic calming devices are intended to reduce the speeds of motor vehicles. Median barriers and traffic channelization devices are considered traffic calming devices. Additional measures may be used in concert with median barriers at crossings to improve safety. Some additional measures include speed humps, curb extensions, pavement markings, and textured pavement. The objective of implementing traffic calming measures is to make the crossing environment safer for all users, motorized and nonmotorized.

3. Design and Construction

This document is not intended to provide formal design criteria or specifications for installing traffic channelization devices at highway-rail grade crossings. Other sources can offer such detailed guidance. Recommendations for typical location plans for crossing signals on divided roadways can be found in the USDOT FHWA *Highway-Rail Grade Crossing Handbook* [5]. The handbook contains design plans for roadways that can accommodate the crossing signals in the median, as well as those with insufficient width in the median. The plans are only intended to be illustrative designs, and any actual installation should be built based on sound engineering judgment and evaluation. Criteria for the design of median islands are also available through the American Association of State Highway and Transportation Officials' publication, *A Policy on Geometric Design of Highway and Streets* [6].

Establishing a uniform process for implementation of traffic channelizing devices at highway-rail grade crossings may facilitate their use. The North Carolina Department of Transportation (NCDOT) and the Southern California Regional Rail Authority (MetroLink) have both issued guidance on median barrier installation. NCDOT issued *Guidelines for Median Separation at Highway-Railway Grade Crossings* [7]. These guidelines were developed to establish consistency and uniformity in median barrier installations throughout the State. Included in the guidelines are installation details and design drawings. These design specifications are included for various roadway configurations and are intended to be a reference for the optimal layout and construction of median separations. MetroLink issued the publication, *SCRRA Highway-Rail Grade Crossings Recommended Design Practices and Standards Manual* [8]. This document includes MetroLink's standards and design criteria for median barrier installation. Standard layout and construction guidance help ensure that the traffic channelizing devices are installed appropriately wherever they are applied throughout the system.

4. Effectiveness

The placement of median barriers and traffic channelization devices at highway-rail grade crossings has become increasingly widespread. Many of these installations have included analytical evaluations on the reduction of risky driver behavior. Driver behavior continues to be the leading cause of incidents at highway-rail grade crossings. Because incidents at grade crossings are relatively rare events, it would be difficult to detect performance differences during an evaluation study. Motorist and pedestrian violations represent a reasonable surrogate, because this behavior is a precursor to grade crossing incidents [9]. A study by Cooper et al. discussed the driver's inability to accurately perceive the distance and speed of an oncoming train [10]. This study suggested that there is "more to be gained by preventing gate running, or at least making it very difficult, than by attempting to aid drivers in making a better informed decision as to whether or not there is sufficient time to clear the crossing before the train arrives." Median barrier and traffic channelization device installations at highway-rail grade crossings discourage drivers from driving around a lowered gate by presenting a physical barrier.

One of the most prominently documented uses of traffic channelization devices at highway-rail grade crossings is on the North Carolina "Sealed Corridor." NCDOT is systematically outfitting the grade crossings along the rail line from Greensborough to Charlotte with SSMs. Because of their relative low cost and high effectiveness, traffic channelization devices are NCDOT's preferred engineering treatment to deter violators at crossings [11]. A total of 189 public crossings were upgraded or closed during the first three phases of the Sealed Corridor initiative (through September 2004). Of those, 18 were outfitted with median barriers. The installation at the Sugar Creek Road crossing shown in Figure 4 resulted in a 77 percent decrease in motor vehicle violations [12]. The Volpe Center conducted an assessment of the grade crossing improvements along the Sealed Corridor. The analysis showed that during the second and third phases of the Sealed Corridor project, the installation of median barriers was found to have "saved" approximately one life from the time of installation until December 2004 [11].

Figure 4. Sugar Creek Road Crossing, NC "Sealed Corridor" (*photo courtesy of NCDOT*)

During 2005, the Massachusetts Bay Transportation Authority (MBTA) conducted an evaluation of the effectiveness of traffic channelization on driver behavior at highway-rail grade crossings. The study was part of a research grant from the Federal Transit Administration (FTA). Flexible median barriers were installed at the Everett Avenue crossing in Chelsea, MA. The study collected a sample size of 500 train events used for baseline and demonstration periods. During the baseline period, 69 instances of unsafe driver behavior were observed. Unsafe driver behavior was classified as (1) vehicle was on the tracks at time of gate activation, (2) vehicle entered the crossing during gate descent, and (3) vehicle circumvented a lowered gate arm.

During the demonstration period, when driver behavior was observed with the median barriers in place, only nine instances of unsafe driver behavior were observed. This led to a reduction of 87 percent in the number of unsafe vehicular events at the crossing [13].

The University of Nebraska, Lincoln, has conducted a number of field tests designed to evaluate driver's response to traffic channelization devices at highway-rail grade crossings. The study at North 141st Street in Waverly, NE, was conducted over a 4-month period. The study evaluated unsafe driver actions before and after the installation of a centerline barrier. The unsafe actions were identified as (1) gate rushing to beat the train, (2) U-turns, (3) wrong side entry (after the barrier installation), (4) taking an alternative route, (5) backing up, and (6) running a red light at a nearby intersection to beat the train. The effects of median barriers were analyzed both by using a comparison *t*-test and a negative binomial model. The results showed a decrease in the total number of unsafe actions after the installation of the median barrier. For example, the mean number of gate rushes decreased by 35.5 percent after the installation [14].

Another similar study was conducted by the University of Nebraska, Lincoln, at M Street in Fremont, NE. The unsafe driver actions were the same as in the Waverly study, except the red light running was not applicable at the M Street crossing. This evaluation looked at three time periods: a baseline period, a period with limited installation in which a median barrier was installed but it did not extend fully to the gates, and a period with a fully installed median barrier. Like the Waverly study, the number of unsafe driver actions (except backing up) showed a significant decrease after the barrier was installed. As was found in the Waverly study, gate rushes were reduced. In this case for the limited and full installation scenarios, gate rushes were reduced by 36.8 and 31.5 percent, respectively [15].

Other studies conducted by the Washington State Department of Transportation and the University of Florida showed decreases of motor vehicle violations by 78 and 96 percent, respectively [3]. These studies prove that installations of median barriers are effective in deterring unsafe driver behavior at highway-rail grade crossings. All of the above-mentioned studies indicate that unsafe driver behaviors at grade crossings were reduced by 68 percent, on average, following the installation of traffic channelization devices. It should be noted that the Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings assigned a 75-percent effectiveness rating to traffic channelization devices, which is in general agreement with these studies.

In addition to reducing the number of unsafe driver actions at highway-rail grade crossings, traffic channelization devices can offer other benefits. When used on the roadway, traffic channelization devices are often used as a means of traffic calming. Traffic calming devices aim to reduce vehicular speeds and promote safe conditions for motorists, bicyclists, pedestrians, and residents. Reduced speeds approaching grade crossings promotes a safer environment and is consistent with virtually all applicable state traffic safety laws governing driver behavior [16]. The presence of traffic channelization devices also attracts attention to the upcoming crossing. Driver awareness of the crossing can facilitate better decisionmaking.

5. Installations at Crossings within a Quiet Zone

One of the most frequent uses of median barriers at highway-rail grade crossings is in conjunction with the establishment of a quiet zone. The Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings set forth a process for the establishment of quiet zones. A community can establish a quiet zone if the Quiet Zone Risk Index (QZRI) is at or below the Nationwide Significant Risk Threshold, if the QZRI is lowered to a level at or below the Risk Index with Horns by implementing sufficient SSMs, or if every crossing in the quiet zone is outfitted with one or more SSM. One of the SSMs identified in this rule is *gates with medians or channelization devices*. As of July 2012, the USDOT National Highway-Rail Crossing Inventory had reports of 1,542 crossings with channelization devices installed; approximately 30 percent of those crossings were within a quiet zone. In the States of Colorado, Kentucky, Massachusetts, and Vermont, the only crossings with channelization devices were located within quiet zones [17].

The use of channelization devices as SSMs must be compliant with the specifications outlined in the rule. The rule allows for two types of centerline barriers: channelization devices and non-traversable curbs (with and without channelization devices). The rule states that channelization devices have an effectiveness rating of 0.75, and non-traversable curbs have an effectiveness rating of 0.80. The effectiveness rating is the reduction in likelihood of a collision at the crossing as the result of the SSM installation.

Per the rule, the channelization devices or median barriers must be installed on both approaches to the crossing. This prevents drivers from circumventing the lowered gates by approaching the crossing in the opposing lane. The median barriers or channelization devices must extend 100 ft in length from the crossing gate arm, or if an intersection is within 100 ft of the crossing, the channelization device must extend 60 ft. Any intersections within 60 ft of the crossing must be closed or relocated. The gap between the lowered gate and the channelization device must be 1 ft or less. Installing a channelization device or a median barrier that meets these specifications will result in risk reduction credit when applying for quiet zone designation.

The Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings also permits channelization devices at quiet zones less than 60 ft to be applied as an alternative safety measure. Alternative safety measures include SSMs that do not fully comply with all the requirements. The benefits of installing channelization devices at quiet zones less than 60 ft have not been quantified.

One major reason that channelization devices are a popular installation at quiet zones is the cost. Communities must improve or maintain their QZRI to justify the creation of a quiet zone.

Traffic channelization devices are a type of SSM that lower the crossing risk at a relatively low cost.

6. Funding

The cost of upgrades and improvements is a universal concern among highway-rail grade crossing safety stakeholders. As established in earlier sections of this study, extremely cost-effective options for traffic channelization are available. However, the installation of barrier walls or curbed medians may require excavation or other preparatory roadwork, which increases the cost of the project. Regardless of the type, however, funding mechanisms are in place to help finance the installation of traffic channelization devices at highway-rail grade crossings.

Federal Funding

The Safe Accountable Flexible Efficient Transportation Equity Act, a Legacy for Users (SAFETEA-LU), was signed into law in 2005. This legislation continued the Highway Safety Improvement Program, which set aside $880 million for distribution (over 4 years) under the Railway-Highway Crossing Program (under 23 USC 130). Projects that are eligible to be funded through the Railway-Highway Crossing Program include, but are not limited to, elimination of hazards, installation of protective devices, and grade crossing separation. The installation of median barriers at highway-rail grade crossings are eligible to be financed under this program. The Railway-Highway Crossing Program limits the federal share to 90 percent of the project costs.

In addition to the Railway-Highway Crossing Program set-aside funds, SAFETEA-LU also makes provisions for improvements at crossings on designated high-speed rail corridors (SAFETEA-LU section 1103 (f)). Eleven corridors in the United States have been identified as federally designated high-speed rail corridors. If median barriers are installed at a crossing along one of these corridors, the project would be eligible for section 1103 (f) funding. Funding levels for this program were $10 million in fiscal year (FY) 2007, $12.5 million in FY 2008, $15 million each in FY 2009, FY 2010 and FY 2011, and $7.1 million for the first 6 months of 2012.

State Funding

Some States have their own grade crossing improvement funds. Illinois, for example, has a Grade Crossing Protection Fund funded by a portion of the motor fuel tax. These funds are available to improve safety at public grade crossings; therefore, median barrier projects may be eligible. Each State funding program will have its own requirements and those requirements should be investigated when pursuing a traffic channelization device installation.

Local Government Funding

As previously mentioned, installing traffic channelization devices at grade crossings is often a low cost means to improve safety. The potential benefits to a community can justify the low price of mountable curbs with upright panels. Local governments may also be willing to fund portions of the project that are outside the normal scope of grade crossing safety improvements.

For example, a redesign of a roadway to accommodate a proper median barrier installation may require the purchase of private property. The town or city is often the authority in the position to approach landowners and negotiate that purchase.

7. Issues and Considerations

FRA promotes traffic channelization as a cost effective means to improve safety at highway-rail grade crossings. A successful median barrier project considers all potential impacts of the installation. If the crossing is on a route that is used by emergency vehicles or heavy trucks, it may be necessary to accommodate a U-turn for these vehicles. This is especially important for “humped” crossings that low-boy trailers could potentially get hung up on. To accommodate U-turns for large vehicles, a potential option is to utilize mountable raised curbs with vertical panels. These installations can be driven over, if necessary. And the replacement of the upright panels is easy and inexpensive. Generally, the maintenance requirements have been low, and the installations are durable. Figure 5 shows a mountable raised curb with vertical panels.

Figure 5. Mountable Raised Curb with Vertical Panels: Upper Lake Road Lexington, NC

A similar concern exists for the installation of median barriers on rural and semirural roadways. Often these rural roads accommodate large farm equipment. The width of these vehicles may be in excess of the lane demarcation, and, therefore, a median barrier at these locations would hinder the movement of these vehicles along the roadway. Roadways that are commonly used by wide vehicles and equipped with traffic channelization devices would likely experience additional maintenance costs as a result.

As stated in the Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings, the recommended length for a median barrier at a highway-rail grade crossing is 100 ft. However, a divided roadway for 100 ft could restrict access to intersecting streets or driveways within the 100-foot zone. An analysis of traffic patterns should be performed to see whether the installation of a median barrier is appropriate for that location. The effectiveness of traffic channelization devices—of less than 60 ft or with breaks for intersecting roadways—in deterring violators has not been established.

Although median barriers have proven effective at deterring motorist gate violations, they do not appear to affect pedestrian behavior. Crossings with an identified pedestrian safety problem cannot assume that traffic channelization devices on the roadway will alleviate the problem. The study done in Chelsea, MA, by the MBTA acknowledged that pedestrian actions at the crossing were unchanged following the installation of the traffic channelization devices [13]. Traffic channelization devices in the roadway median are not an effective measure to improve pedestrian safety at highway-rail grade crossings.

The installation of traffic channelization devices at highway-rail grade crossings requires the cooperation of many stakeholders. It is in the interest of the railroad to improve safety at the crossing, and often the industry is the chief proponent of outfitting a crossing with traffic channelization devices. However, because the traffic channelization devices extend 60 to100 ft beyond the right of way, the roadway authority must also be involved. Local government involvement is also recommended to get buy-in to the project. Involving the local governing authorities in the process will help address any community concerns about the impact of the installation.

8. Conclusions

FRA encourages highway traffic engineers to consider the use of traffic channelization devices at highway-rail grade crossings with active warning devices. The use of traffic channelization should be determined on a crossing-by-crossing basis. Some crossings may require the roadway to be widened to accommodate the median barriers. Others may have intersecting streets or driveways within 100 ft of the crossing. The application of sound engineering judgment is advised for any safety improvement project.

The installation of traffic channelization devices at highway-rail grade crossings has proven to be a cost-effective means of improving safety. Median barriers that meet the criteria within the Final Rule on the Use of Locomotive Horn are approved SSMs for the establishment of a quiet zone.

Implementing median barriers at a highway-rail grade crossing with active warning devices can reduce the risk of a collision at that crossing. Many studies have shown that the installation of traffic channelization devices significantly reduced driver violations at highway-rail grade crossings. When considered together, the studies indicate that the installation of traffic channelization devices at highway-rail grade crossings reduces unsafe driver behaviors by an average of 68 percent. Thus, the conclusion can be drawn that median barrier installations will reduce the likelihood of a collision at highway-rail grade crossings.

9. References

1. U.S. Department of Transportation, Federal Railroad Administration, Railroad Accident-Incident Reporting System – Highway-Rail Accidents, July 2012.
2. U.S. Department of Transportation, Federal Railroad Administration, "Guidance on the Use of Traffic Channelizing Devices at Highway-Rail Grade Crossings," Washington, DC: U.S. DOT, January 2008.
3. Code of Federal Regulations Volume 4, Title 49, Parts 222 and 229, "Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings," August 17, 2006.
4. U.S. Department of Transportation, Federal Highway Administration – Technical Working Group, "Guidance on Traffic Control Devices at Highway-Rail Grade Crossings," Washington, DC: U.S. DOT, November 2002.
5. U.S. Department of Transportation, Federal Highway Administration, "Railroad-Highway Grade Crossing Handbook – Revised Second Edition 2007," Report FHWA-SA-07-010, Washington, DC: U.S. DOT, August 2007.
6. American Association of State Highway and Transportation Officials, "A Policy on Geometric Design of Highways and Streets, 5th Edition", Washington, DC, 2004.
7. State of North Carolina Department of Transportation, "Guidelines for Median Separation at Highway/Railway At-Grade Crossings," Raleigh, NC: NCDOT, February 2008.
8. Southern California Regional Rail Authority, "SCRRA Highway-Rail Grade Crossings Recommended Design Practices and Standards Manual," June 2009.
9. Abraham, J., Datta, T., and Datta, S. "A Study of Surrogate Measures for Rail-Highway Crossing Accidents," prepared for Transportation Research Board, Washington, DC, January 1997.
10. Cooper, D.L., MacLeod, K.E., and Ragland, D.R. "Rail Crossings: A Strategy to Select Countermeasure Improvements for Rail-Highway Crossings in California," prepared for the Transportation Research Board, Washington, DC, January 2007.
11. Bien-Aime, P. "North Carolina Sealed Corridor Phase I, II and III Assessment–Draft Report," prepared for Federal Railroad Administration, Cambridge, MA: U.S.DOT, August 2009.
12. U.S. Department of Transportation, Federal Railroad Administration, Office of Railroad Development, "North Carolina Sealed Corridor Phase I U.S. DOT Assessment Report," May 2002.
13. Wickham, K., and Cuthbertsome, D. "Study on Median Barriers for Traffic Channelization at Grade Crossings," Report FTA-MA-26-7057, prepared for Federal Transit Administration, Washington, DC: U.S. DOT, June 2008.
14. Khattak, A.J. "Reducing Undesirable Actions of Motor Vehicle Drivers at Railroad–Highway Grade Crossings," Transportation Research Record: Journal of the Transportation Research Board, No. 2030, Transportation Research Board, Washington, D.C., 2007, pp. 54–58.
15. Khattak, A.J., and McKnight, G.A. "Gate Rushing at Highway-Railroad Grade Crossings," Transportation Research Record: Journal of the Transportation Research Board, No. 2056, Transportation Research Board, Washington, DC, 2008, pp. 104-109.

16. Jennings, L. S. "Compilation of Laws and Regulations Affecting Highway-Rail Grade Crossings, Fifth Edition," prepared for Federal Railroad Administration, Washington, DC: U.S. DOT, October 2009.
17. U.S. Department of Transportation, National Highway-Rail Crossing Inventory, July 2012.

Abbreviations and Acronyms

FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FY	fiscal year
MBTA	Massachusetts Bay Transportation Authority
MetroLink	Southern California Regional Rail Authority
NCDOT	North Carolina Department of Transportation
QZRI	Quiet Zone Risk Index
RITA	Research and Innovative Technology Administration
SAFETEA-LU	Safe, Accountable, Flexible, and Efficient Transportation Equity Act – A Legacy for Users
SSM	supplemental safety measure
USDOT	U.S. Department of Transportation
Volpe Center	John A. Volpe National Transportation Systems Center