Measure Name: Four quadrant gates

Definition: Gates at all four quadrants of a grade crossing to block road users from entering and exiting the grade crossing while activated.

Tags:

Type of Incident:

☐ Non-Motorized Users Only
☐ Motor Vehicles Only
☒ Both

Intervention Strategy:

☐ Data: application and planning
☐ Education: outreach and messaging
☐ Enforcement: policy development and rulemaking
☒ Engineering: technological and physical deterrents

Type of Problem:

☐ Non-Motorized Users Violating Warning Devices
☒ Motor Vehicles Violating Warning Devices
☐ Vehicle ROW Incursion
☐ Vehicle Congestion
☐ Blocked Crossing
☐ Vehicle Hang-up

Measure Category:

☐ Risk Assessment
☐ Policy and Enforcement
☐ Collaboration, Training, and Education
☐ Public Communication
☒ Physical Barriers
☐ Detection and Lighting
☐ Infrastructure Modification
☐ Post-Incident Management
☒ Warning Devices

Description

Four quadrant crossing gates refers to the installation of gates at all four quadrants to block road users from entering and exiting the grade crossing. This measure works by temporarily closing the grade crossing with gate arms across the entire roadway on both sides during an activation to prevent vehicles from driving around lowered gates. The four-quadrant gate system consist of series of drive mechanisms and fully retro reflectorized red- and white-striped gate arms with lights [1]. When activated, this traffic control device gives road users a positive indication of incoming rail traffic and blocks access to the crossing by extending the gate arm across both entrance and exit lanes of the roadway. The exit gates can be operated in either dynamic or timed mode. In dynamic mode, exit gate function is dependent on the presence and detection of vehicles within the grade crossing. In the timed mode, the exit gate activates on delay timer to allow vehicles to clear the crossing zone. [2]

The effectiveness of upgrading a crossing from automatic gates with flashing lights and bells to four quadrant gates are as follow: [3]

- Four-quadrant gates without obstruction detection: 0.82
- Four-quadrant gates with obstruction detection: 0.77
- Four-quadrant gates with medians of at least 60 feet (with or without obstruction detection): 0.92

It should be noted that higher effectiveness rate for four-quadrant gates without obstruction detection does not mean they are safer than ones with obstruction detection. Presence of obstruction detection can cause exit gate to remain up when there are vehicles in the crossing zone. This could lead to other motorists driving around lowered entrance gate. [4]

Additional search terms: *4quad, active crossing, full barriers, barriers*

Advantages

- Four-quadrant gates with obstruction detection is an excellent solution in situations where grade separation or closure are precluded. [5]
- Measure provides an automatic warning and restriction when a train is approaching.
- Prevents motorists from going around lowered entrance gate.
- Measure is an approved supplementary safety measure to establish a quiet zone crossing. [3]

Drawbacks

- Four-quadrant gate systems can be expensive to install and maintain.
- Could result in vehicles being trapped on the crossing at four-quadrant crossing without obstruction detection or due to obstruction detection malfunctioning.
- Drivers are less likely to comply with the warning devices if warning is too long. [5]

Notable Practices

- Refer to relevant standards/guidelines for four-quadrant gate systems in the Manual on Uniform Traffic Control Devices. [1]
- Measure will require regular maintenance, inspection, and testing per 49 CFR Part 234. [4]
- When the gates are fully deployed in the down position, the individual gate arm shall extend across the entrance and exit lanes of the roadway. [1]
- The exit gate shall be designed to fail-safe in the up position except if the crossing is equipped with remote health (status) monitoring. [1]
- Ensure that the counterweights and support arms for the automatic gates for vehicular traffic do not obstruct the sidewalk when the gate is fully lowered. [2]
- Where automatic gates are installed, the stop line should be located approximately 8 feet in advance of where the gate arm crosses the highway surface. [2]
- It is desirable to place crossing gates perpendicular to the direction of travel on the approach roadway. [2]
- The gates can be installed on the other side of the sidewalk to also block pedestrians. However, it is preferred that pedestrian gates are mounted on a mechanism separate from the roadway gates.

References

[1] Federal Highway Administration. (2012). Manual on Uniform Traffic Control Devices.

Document Excerpt: The Manual on Uniform Traffic Control Devices (MUTCD), by setting minimum standards and providing guidance, ensures uniformity of traffic control devices across the nation. The use of uniform TCDs (messages, locations, sizes, shapes, and colors) helps reduce crashes and congestion, and improves the efficiency of the surface transportation system. Uniformity also helps reduce the cost of TCDs through standardization. The information contained in the MUTCD is the result of years of practical experience, research, and/or the MUTCD experimentation process. This effort ensures that TCDs are visible, recognizable, understandable, and necessary. The MUTCD is a dynamic document that changes with time to address contemporary safety and operational issues.

[2] U.S. Department of Transportation. (2019). Highway-Rail Grade Crossing Handbook – Third Edition.

Abstract: The purpose of the *Highway-Rail Crossing Handbook, 3rd Edition* is an information resource developed to provide a unified reference document on prevalent and best practices as well as adopted standards relative to highway-rail grade crossings. The handbook provides general information on highway-rail crossings; characteristics of the crossing environment and users; and physical and operational changes that can be made at crossings to enhance the safety and operation of both highway and rail traffic over such intersections. The guidelines identified and potential alternative improvements presented in this handbook reflect current best practices nationwide.

[3] U.S. Department of Transportation Federal Railroad Administration. (2006). Use of Locomotive Horns at Highway-Rail Grade Crossings; Final Rule.

Description: The Final Rule on the Use of the Locomotive Horns at Highway Rail Grade Crossings (Code of Federal Regulations Title 49 Parts 222 and 229) permits the use of traffic channelization devices or non-traversable curbs that meet specific requirements as supplemental safety measures (SSM).

[4] Code of Federal Regulations. (2022). 49 CFR Part 234 – Grade Crossing Safety.

Excerpt: This This part prescribes minimum maintenance, inspection, and testing standards for highway-rail grade crossing warning systems.

[5] Hellman, A., Ngamdung, T. (2009). Illinois High-Speed Rail Four-Quadrant Gate Reliability Assessment. Technical Report No. DOT/FRA/ORD-09/19. Washington, DC: U.S. Department of Transportation, Federal Railroad Administration.

Abstract: The Federal Railroad Administration (FRA) tasked the John A. Volpe National Transportation Systems Center (Volpe Center) to conduct a reliability analysis of the four-quadrant gate/vehicle detection equipment installed on the future high-speed rail (HSR) corridor between Chicago and St Louis. A total of 69 highway-rail grade crossings on a 121-mile (195 km) segment of the 280- mile corridor were equipped with four-quadrant gates and inductive loop vehicle detection technology. This segment, between Mazonia and Springfield Illinois, will eventually carry passenger trains at speeds up to 110 mph (177 km/h) at many of the highway-rail grade crossings.

The analysis was based on maintenance records obtained from the Union Pacific Railroad (UPRR), the owner and operator of the highway-rail grade crossings. The results were used to assess the impact of the equipment reliability on the proposed HSR timetable. The Volpe Center study showed that the total average delay to the five scheduled daily high-speed passenger roundtrips was an estimated 38.5 minutes, or approximately four minutes per train. Overall, extensive analysis of the trouble ticket data showed that the four-quadrant gate and vehicle detection equipment had a minimal direct impact on the frequency and duration of grade crossing malfunctions.

Additional Recourses

Hellman, A., Carroll, A., and Chappell, D. (2007). Evaluation of the School Street Four-Quadrant Gate/In-Cab Signaling Grade Crossing System. Technical Report No. DOT/FRA/ORD-07/09. Washington, DC: U.S. Department of Transportation, Federal Railroad Administration.

Abstract: Under sponsorship from the U.S. Department of Transportation Federal Railroad Administration, Office of Research and Development, the John A. Volpe National Transportation Systems Center performed an evaluation of the four-quadrant gate/obstruction detection system at the School Street crossing in Groton, CT. The primary objectives of this evaluation were to assess the safety benefits and to document the operational performance provided by this non-standard technology. Highway-railroad grade crossing risk mitigation research in the United States has historically focused on the safety benefits of active warning devices, such as flashing lights, bells, and dual crossing gates. In addition, clear agreement has predominated within the research community that grade separation or closure provides the highest level of risk treatment. As the economic and societal costs of these treatments have increased, however, research has been increasingly concentrated on technologies that provide many of the same benefits without the obtrusiveness of grade separation or closure.

Related Measures

- Automatic gates
- Barrier gates
- Long gate arm
- Traffic channelization
- Pre-signals

Images

Figure 1. Example of four quadrant crossing gates at a grade crossing in Harrisburg, NC
Image Credit: Volpe Center

Figure 2. Example of four quadrant crossing gates at a grade crossing in Gardner, IL
Image Credit: Volpe Center

Figure 3. Example of four quadrant crossing gates at a grade crossing in Groton, CT
Image Credit: Volpe Center