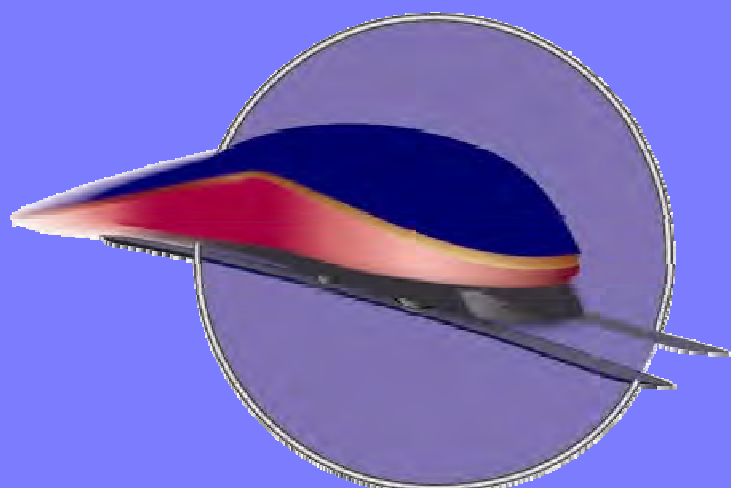
Appendix 5.4.4

FRA Published Highway-Rail Grade Crossing Guidelines for High-Speed Passenger Rail

Highway-Rail Grade Crossing Guidelines for High-Speed Passenger Rail



Office of Railroad Safety
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Contents

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Preface to Version 1.0

On July 28, 2009, FRA distributed for comment, through the Railroad Safety Advisory Committee (RSAC) and its member organizations, an initial draft of these Highway-Rail Grade Crossing Guidelines (Guidelines). Comments were requested through August 28, 2009, and a report on the comments was provided to the RSAC at its meeting on September 10, 2009. Subsequently, FRA published a notice concerning the establishment of a public docket (FRA Docket No. 2009-0095) which will remain open indefinitely to receive comments on the High-Speed Rail (HSR) Safety Strategy and this document (74 FR 50270; Sept. 30, 2009).

In preparing these Guidelines, FRA has taken into consideration all of the comments that touched on the issue of highway-rail grade crossings in high-speed territory, as well a comment on the Notice of Proposed Rulemaking for Positive Train Control Systems (74 FR 35950; July 21, 2009)(FRA Docket No. 2008-0132). In general, there was continued strong support for consolidating both public and private highway-rail grade crossings. Beyond that, FRA encountered a wide range of views in these comments, from strong support for aggressive engineering that would include integration of highway-rail warning systems with train control to concerns that excessive expectations could arrest progress toward new rail service.

Any discussion of rail passenger service and safety draws notable comments regarding costs, funding, and liability. Likewise, host or tenant freight railroads conducting operations on lines used for Emerging HSR are concerned that provisions for safety might disrupt or unduly burden freight service. Responses to the draft Guidelines were replete with such comments.

FRA has attempted to take into account issues of cost and practicability in adopting these initial Guidelines. FRA has also taken into account the compelling reality that HSR service will succeed only if it is very safe. Exposure at highway-rail grade crossings is the area of risk over which it is most difficult to establish reasonable control, specifically because two independent modes of transportation are involved. Accordingly, FRA offers Guidelines that attempt to advance safety and take advantage of techniques successfully implemented on one or more existing high-speed corridors.

Two observations are crucial: First, these are guidelines, not regulations. They do not establish a standard of care, and no court should view any departure from these guidelines as suggesting a failure to exercise reasonable care. Second, they should be taken seriously by those who are planning high-speed service. They will be used, with other relevant factors, in determining the relative merit of applications for Federal assistance, and they will be used by FRA as grant agreements are negotiated. Of course, as guidelines, they will be weighed in the particular context along with other considerations advanced by the applicant. FRA is aware that very safe HSR service has been provided under conditions not wholly aligned with the guidelines, so they should not be applied reflexively or arbitrarily. At the same time, applicants should keep in mind that serious rail passenger accidents are rare events, and that abating risk can make them even less frequent. Waiting for the first event to happen is a sure formula for failure.

One commenter suggested that elements of the Guidelines should "rise to the level of regulation." FRA has a completely full regulatory agenda for the time being; however, the agency remains open to including additional standards development in the High-Speed Rail Safety Strategy as resources permit.

Finally, FRA notes that these Guidelines will remain a work in progress. The dialogue that has been possible over the past months has been severely constrained by the demands imposed on FRA and its colleagues by the Rail Safety Improvement Act of 2008, the Passenger Rail Investment and Improvement Act of 2008, and the American Recovery and Reinvestment Act of 2009. Together, these legislative actions present substantial opportunities supporting growth in passenger rail service and improvements in railroad safety.   FRA will maintain an active dialogue with all of those participating in this historic process and refine safety strategies to address these opportunities.

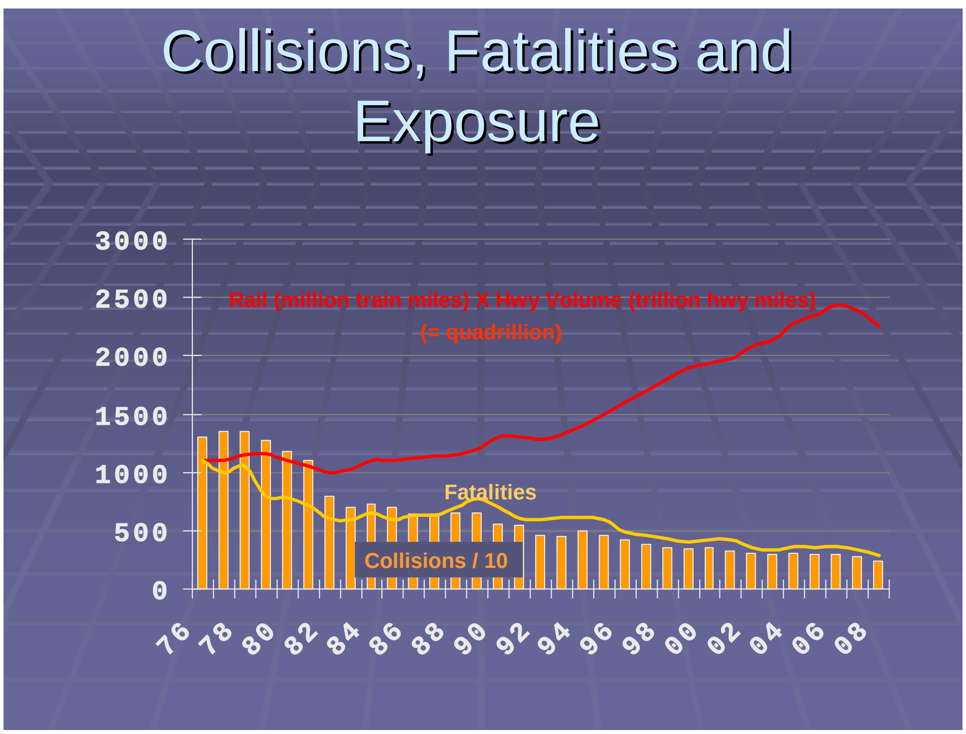
Introduction

Highway-rail grade crossings pose inherent hazards to train operations, as they do to motor vehicles, non-motorized vehicles, and pedestrians. Since the issuance of the Secretary's Highway-Rail Grade Crossing Action Plan in 1994, U.S. Department of Transportation (DOT) policy has supported consolidation of crossings on active rail lines. Where an at-grade crossing cannot be eliminated, provisions must be made to ensure that the roadway approaches and crossing surface are suitable for all traffic, that sufficient warning is provided of the approach of trains, and that management of the highway-rail intersection is coordinated with other intersections involving nearby roads. In addition to the consolidation of crossings and engineering improvements at crossings that remain, DOT policy has stressed—

- Education and awareness to prepare drivers for challenges at highway-rail grade crossings; and
- Enforcement of traffic laws at crossings.

In addition, the Federal Railroad Administration (FRA) has taken actions to better ensure the conspicuity of rail equipment and to provide for effective audible warnings or compensating safety measures.

The national grade crossing partnership—consisting of DOT agencies, States, Operation Lifesaver Inc., railroads, suppliers, and the research community—has been very effective in reducing collisions and casualties at grade crossings even in the face of rising exposure (which may be measured by motor vehicle miles and train miles).



This general approach is equally relevant without regard to the type or speed of rail traffic. However, where rail lines carry high-speed passenger trains, special care must be observed to ensure that road traffic does not present an obstruction that could result in a collision and subsequent derailment. The presence of both high-speed passenger trains and slower-moving trains creates another dimension of risk, warranting[1] additional attention to governance of all traffic over the highway-rail intersection. Under these circumstances, exclusive reliance on sight distance or audible warnings to judge the arrival of trains is not practical. Particularly where there are two or more tracks, the potential for an event involving more than the single train initially impacting a road user adds to the potential for additional risk.

Accordingly, at crossings with high-speed passenger trains, special care must be taken to follow existing guidance concerning a systems approach to highway-rail grade crossing safety. This includes the use of diagnostic teams to plan improvements, elimination of redundant crossings and those that cannot be re-engineered to provide reasonable safety, the use of automated warning devices including constant warning time circuitry where feasible, and other sound safety approaches as set forth in the Manual on Uniform Traffic Control Devices (MUTCD) and Railroad-Highway Grade Crossing Handbook, both published by the Federal Highway Administration.

In addition, FRA requirements for approved barrier systems where train speeds exceed 110 mph and the prohibition of at-grade crossings where train speeds exceed 125 mph must be observed as provided in the Track Safety Standards.

Although these fundamentals are very important, they will not be sufficient to meet the safety challenges associated with high-speed passenger rail going forward. Accordingly, the purpose of this document is to provide supplementary guidance useful to those planning high-speed passenger service and to FRA as guidance for the negotiation of funding agreements and for the administration of the Track Safety Standards (i.e., with respect to the characteristics of barrier systems suitable for approval). This guidance restates and supplements preexisting guidance, building on experience gained through projects initiated under the Intermodal Surface Transportation Efficiency Act and subsequent surface transportation legislation, engineering options proven during development of the Train Horn Rule, and continuing research. This experience shows that the safety challenges associated with high-speed rail (HSR) can be effectively met.

The primary purpose of this guidance is to support the highest level of safety that is practical, given the necessity associated with those highway-rail crossings that remain after efforts toward consolidation are complete. However, it must also be recognized that collisions at highway-rail grade crossings disrupt rail passenger service and local road use. Accordingly, in addition to saving lives, preventing injuries, and avoiding property damage, actions that effectively reduce risk at these locations will pay dividends in more reliable service that will enjoy a reputation for quality as well as safety. Good planning that

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[1] Variants of the term "warrant" as used in the Guidelines are intended to have their common meaning. This document does not prescribe "warrants" as the term is used in highway engineering.

consolidates crossings and substitutes grade separations for at-grade crossings will significantly enhance mobility and contribute to livable communities.

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Guidance for Highway-Rail Grade Crossings

1. Consolidation and Grade Separation

As emphasized in the Secretary of Transportation's 2004 *Action Plan for Highway-Rail Grade Crossing Safety and Trespass Prevention*: "The Department supports efforts to close crossings and limit the creation of new highway-rail crossings except where the public interest clearly provides justification."[2] Regardless of anticipated train speeds, any new or enhanced passenger service should begin with an aggressive effort to close redundant crossings and those that cannot be re-engineered to provide a reasonable level of safety (e.g., because of geometry, proximity of road intersections).[3] Consolidation of at-grade crossings requires significant effort, but pays off in real results and reduced costs. Accordingly, crossing consolidation is the cornerstone of effective planning for high-speed passenger rail.

Effort and results in minimizing the number of highway-rail grade crossings will be considered favorably when evaluating competing funding requests, given the finite resources that are available for transportation improvements, and given the fact that crossing closures are typically very cost-effective when compared to the alternatives (upgrading warning devices, maintaining warning devices and crossing surface through the program lifecycle, additional expense associated with maintenance of track structure at crossing location, etc.).[4] Clearly, consolidation planning must consider the need for crossings adjoining those that are closed to be equipped with high-quality warning systems so that safety is advanced.[5]

Multi-track crossings pose special problems, especially where some trains are expected to move slowly in approach to yards or stations while others proceed at higher speeds on an adjacent track. Where there are more than three tracks, or where frequent low-speed movements are expected, strong consideration should be given to closure or grade separation. Mobility and safety will demand it. By involving road authorities and metropolitan planning agencies early on, opportunities for cooperative efforts toward grade separations can be identified and built into project plans.

2. Safety Improvements at Private Crossings

Private highway-rail crossings constitute a significant part of the crossing safety problem in the United States, and in most States, there is no public regulation of this issue. On average, movements over private crossings are a greater risk to persons on trains because of the

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[2] *Secretary's Action Plan, Highway-Rail Crossing Safety and Trespass Prevention,* DOT (June 2004), (available at http://www.fra.dot.gov/us/content/1752), page 7.
[3] *See* *Highway-Rail Grade Crossings – A Guide to Crossing Consolidation and Closure,* FRA and FHWA (June 1994), (available at http://www.fra.dot.gov/us/content/1752).
[4] In this setting, demonstrated effort would include making application to a state agency having authority to order closure (where such authority exists).
[5] Some have suggested that FRA specify a maximum number of crossings per mile. Although FRA is hesitant to specify a number (e.g., 2) given the agency's inability to enforce such a limitation, FRA recognizes that the number—apart from grade separated crossings—should be very small.

prevalence of heavy trucks and agricultural equipment.[6] Closing private crossings should be an integral part of the crossing safety strategy for any HSR corridor. Cost-effective access can often be provided to the crossing holder by establishing an alternative route as part of the HSR improvements even though such alternatives are not currently present. Where a private crossing cannot be closed, the crossing should be evaluated according to its use and appropriately treated.

a. Public Access Crossings

Very often, private roads are open to public use, such as where the public is invited to enter a shopping mall or entertainment venue. In general, these "public access crossings" should be treated in the same manner as any public grade crossing, and their inclusion in crossing consolidation programs is similarly desirable.

b. Industrial Crossings

Industrial crossings often pose special threats to trains because competing roadway traffic consists of heavy trucks that may also be transporting hazardous commodities. Typical locations include gravel pits, chemical and energy plants, steel and aluminum production facilities, warehouses, intermodal transfer facilities, and many others. Each of these crossings should be evaluated individually to ensure proper advance signage, adequate active warning, suitability of roadway approaches (including elimination of "hump" crossings capable of hanging up low-profile vehicles), adequate storage distance for longer combination vehicles between tracks and nearby traffic intersections, presence of traffic-calming devices approaching the crossing that are compatible with the road traffic, and effective barrier systems where required (see below).

Ongoing training and awareness efforts for drivers regularly using the crossing will also be important to ensure familiarity with the crossing safety system and the importance of observing warnings.

c. Residential Crossings

Private roads used to access individual residences and residential developments inevitably draw business guests (mail delivery persons, repair personnel, gardeners, etc.) as well as personal guests and the residents themselves. Although it may be impractical to treat every such location as a public access crossing, crossings providing access to multiple residences should be so considered. One commenter on these guidelines suggested a rule of thumb of 5 or more residences constituting public access for a single crossing location, which appears to be a reasonable compromise.

There is also precedent for using gate arrangements at the crossing to control access to residential developments. In one approach, gates are normally down at the crossing and access is provided by an electronic card system or frequently changed code. The gate rises

[6] See *Private Highway-Rail Grade Crossing Safety Research and Inquiry*, Office of Research and Development and Office of Safety, FRA (May 2008)(available at http://www.fra.dot.gov/us/content/1712).

and provides access to the development only if there is no train on the approach circuit. The suitability of this arrangement would depend on assignment of responsibility for maintenance and proper control of the means of entry (e.g., cards, tags, codes). The design of the system should ensure that gates will close behind the authorized user to prevent later unauthorized access. Another approach is to treat the crossing in the same manner as a public crossing, which would include the use of flashing lights and gates, plus any other appropriate treatment.

If it is not financially feasible to provide automated warning devices at a crossing providing entry to one or two residences, special care should be taken to ensure that the crossing is well marked with a crossbuck and either a yield or stop sign, and that sight distances are adequate for all types of vehicles expected to use the crossing. Appropriate attention should be afforded to the crossing surface, including adequate width. If train speeds exceed 90 mph at the location, flashing lights and gates should be provided in each case. High-speed trains present elusive visual targets and will close on a crossing too rapidly for audible warnings to be effective.

d. Agricultural Crossings

Thousands of agricultural crossings will remain on Emerging HSR corridors in the coming years as they are necessary to provide access to fields in season and for other legitimate purposes. However, as operating speeds increase, the danger of a catastrophic incident involving heavy agricultural machinery and a passenger train will also rise. Casual and unauthorized users (moving over the crossing to hunt, fish, or engage in other recreation) pose a special risk to themselves and others because of the potential lack of familiarity with rail traffic on the line and because of crossing approaches, sight lines, and surface that may be less than optimal.

For Emerging HSR, the most rudimentary approach to agricultural crossings that cannot be permanently closed is to require that they be closed *when not in use* by employing a locking device within the control of the crossing holder. A simple padlock on a fence gate may be sufficient in many cases. However, experience shows that getting manual locks re-secured after passage of the authorized user can be a problem. Further, limited sight distances or the relatively long clearance time required for heavy agricultural machinery will often indicate a more aggressive approach.

As passenger rail speeds increase, systems that provide active warning, controlled opening of the crossing, and provide feedback when it is secured are very desirable. This is particularly true when sight distances are limited (as would be true where track curvature or multiple tracks, vegetation (including seasonal issues involving tall crops), topography or other factors block sight distance for any period of time). The potential for adverse weather (e.g., heavy rain, snow, or fog) should also be considered. For many locations, an electronic lock with a timed release controlled through the signal or train control system may be more cost-effective and appropriate than a traditional arrangement with flashing lights and gates. These arrangements could take into consideration the maximum time typically required to move equipment over the specific crossing and could provide feedback through the train control system if the crossing remains open beyond the specified period.

3. "Sealed Corridors"

In guidance provided through the 1990s, the DOT advocated for a minimum of active warning systems with gates, controlled by constant warning time circuitry, on rail lines with speeds of 80 mph and greater.[7] Gates provide an unequivocal indication to the motorist regarding the behavior expected. This continues to be a good foundation for crossing safety on HSR lines, but developments since that time point the way to additional strategies.[8]

The State of North Carolina has pioneered many of the subsequent advances on the North Carolina Railroad under the concept of a "Sealed Corridor."[9] NCDOT defines the concept as follows:

> An extended rail corridor or segment thereof on which all public at-grade crossings are evaluated through an engineering diagnostic process to determine the appropriate level of safety improvement needed to decrease or eliminate violations. Safety improvements include closure/consolidation, enhanced warning devices, medians, and grade separation. The end result is that redundant and/or unsafe crossings are consolidated through closure and/or grade separation and all remaining public crossings are equipped as appropriate with four quadrant gates, median separators, and longer gate arms. Private crossings are also evaluated for closure, signal treatment and/or special signage.

In keeping with that concept, public crossing treatments for Emerging HSR lines should provide an additional level of safety by blocking all lanes of travel. These types of arrangements add safety by preventing left turns from parallel roadways that inadvertently result in driving around the tip of the gate arm. They also discourage those who might attempt to go around the lowered gate. This can be accomplished using one or more of the following—

- Four-quadrant gates
- Median arrangements
- Paired one-way streets with gate arms extending across all lanes of travel[10]

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[7] *High-Speed Track and Equipment Safety Standards* (Report to the Committees on Appropriations, May 1997), page 7.
[8] Constant warning time circuitry may not be practical on electrified rail lines under some conditions (including the nature of the legacy train control system). If that is the case, special care should be given to ensuring that warning system traffic control at the crossing is observed.
[9] Reports and other information on North Carolina's Sealed Corridor can be accessed online at http://www.bytrain.org/safety/sealed.html and http://www.fra.dot.gov/downloads/Research/rr0807.pdf.
[10] NCDOT has also found long gate arms to be effective on two-lane roads with travel in both directions. However, they have also found them to require significant maintenance.

These types of improvements have been accepted by the highway engineering community and the railroads in connection with programs for enhanced passenger rail service and in connection with quiet zones.[11] They can be paired with selective use of barrier gates at particularly troublesome crossings.

FRA expects that funding proposals will reflect sealed corridor treatments for all highway-rail grade crossings at locations where train speeds exceed 79 mph. FRA will look favorably on proposals for locations within the limits of developing high-speed corridors that include sealed corridor treatments at crossings with maximum authorized train speeds below that threshold.

It should be noted that sealed corridor treatments are also appropriate at crossings with more than two tracks, regardless of speed, and particularly near passenger stations. These are cases where "second train" concerns can be particularly acute. Additional warning time will be required at these locations to ensure that all road traffic clears the crossing. Pedestrian gates and effective channelization should be provided.

4. Warning Systems and Other Highway Traffic Control Devices

Automatic warning devices at crossings (such as flashing lights and gates) provide valuable information to the motorists that are approaching the crossing. These devices may be supplemented by additional systems and traffic control devices to enhance the effectiveness of the warning systems. These additional systems should be carefully considered at crossings on HSR lines.

a. Interconnection and Supplementary Traffic Control

Warning systems in HSR lines must conform to the MUTCD and other Federal Highway Administration guidance. Special attention should be given to the interconnection of grade crossing warning systems with other traffic control systems in the vicinity of the crossing, and periodic verification that timing is adequate to avoid "storage" of vehicles on the crossing (i.e., vehicles that are stopped on the crossing due to traffic that is queued because of the highway traffic signal). Actual conditions may indicate the necessity of interconnection even though the nominal MUTCD threshold is not met.

In some cases, heavy highway traffic volume may defy reasonable attempts to use timing of the highway traffic signal as the means of preventing storage. Since storage of a large truck or bus could pose a hazard to persons on and off the train, consideration should be given, where appropriate, to the use of interconnected traffic signals prior to the crossing and placed specifically to prevent storage. A traffic engineering study should be conducted to determine the appropriate timing for the interconnection and whether the interconnection

[11] Title 49 Code of Federal Regulations (CFR) Part 222.

should be simultaneous or advanced preemption. The use of pre-signals and queue-cutter signals should also be explored where warranted.[12]

b. Presence Detection

Accepted design for four-quadrant gates includes a delay on the descent of exit gates to permit traffic on the crossing to clear before arrival of the train. Where a four-quadrant gate system is employed and storage is a potential issue, consideration should be given to using vehicle presence detection to maintain the exit gates in the raised position until traffic within the crossing clears.[13]

Storage may also be an issue where conventional gates and channelization through use of medians is employed. For crossings where storage is a known possibility, and in the case of crossings on segments with train speeds above 100 mph, regardless of a prior history of storage, presence detection should be provided in connection with operation of the train control system (see below). Motor vehicles stalled or trapped on a crossing present a derailment hazard; and in multiple track territory or where freight equipment is standing on adjacent sidings or industry tracks, derailments can result in catastrophic secondary collisions.

c. Remote Health Monitoring

Warning systems are designed to be fail-safe. However, the potential for continuous operation (eroding the credibility of the warning), intermittent malfunction, or even total failure is always present. Confidence in warning system performance is acquired through many means, including periodic inspections and tests,[14] emergency notification systems, constant attention by train crews. In recent years, the additional option of remote health monitoring has been added. Grade crossing controllers and simple sensors together can diagnose developing problems and failures (including failure of commercial power and system unresponsiveness caused by lightning strikes and other factors). By using cellular phone links and other communication paths, crossing warning systems can report problems to a central location, leading to responsive action by dispatchers, train crews, and signal maintainers. Use of remote health monitoring on HSR lines is clearly indicated. Typically, exceptions are reported to a signal trouble desk for review and action. However, unless the signal trouble desk is continuously monitored, critical exception data from health monitoring should also be presented to dispatchers for acknowledgment and appropriate action.

FRA will include consideration of these issues in its review of grant applications and in negotiation of grant agreements.

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[12] *See* *Railroad-Highway Grade Crossing Handbook*, FHWA (August 2007), (available at http://www.fra.dot.gov/us/content/1752), pages 114-115, 129, and 134.
[13] NCDOT advises that decisions on presence detection and whether gates are designed to fail up or down should be entrusted to the crossing safety engineer in charge or to the diagnostic team.
[14] *See* 49 CFR Part 234.

5. Train Control Integration

One of the potential functions of a train control system is to provide the locomotive engineer with information concerning route conditions ahead. FRA has in place existing train control requirements for operations above 79 mph.[15] On July 21, 2009, FRA published a proposed rule on Implementation of Positive Train Control (PTC) systems as required by the Rail Safety Improvement Act of 2008.[16] PTC will be required by law on all intercity and commuter passenger lines by December 31, 2015.

The question arises whether the train control system can be engaged as a means of preventing certain low-frequency, high-severity collisions involving vehicles that linger on grade crossings as a result of being stored, disabled, or deliberately placed there.

The following examples illustrate recent experiences:

- One of the primary objectives of Federal and local investment in the Northeast Corridor (NEC) from the 1970s through the 1990s was the elimination of highway-rail grade crossings. In fact, all crossings were eliminated south of New York City, and only a half dozen (mostly lightly used) crossings remain north of New York City. Anticipating the enhancement of HSR service between New Haven and Boston, FRA acted through an Order of Particular Applicability for the Advanced Train Control and Advanced Civil Speed Enforcement System (affecting certain NEC railroads) to address residual grade crossing risk on that territory.[17] The Order limited speeds to 80 mph with conventional crossing treatments, and to 95 mph where four-quadrant gates were present with presence detection and a feedback loop to the train control system that would cause the cab signals to display the most restrictive signal aspect if a vehicle was stored on the crossing after the exit gates timed out. (Amtrak ultimately elected to take a more conservative approach than required, equipping additional crossings with four-quadrant gate systems tied into the train control system.) FRA's justification for the requirements was directly related to the specifics of the NEC operation.

- In Michigan, Amtrak's line (which is part of the Detroit-Chicago corridor) is equipped with the Incremental Train Control System. This system functions to provide pre-starts for highway-rail grade crossings, avoiding the expense and complexity of extending approach circuits to provide proper warning for high-speed trains. Using a radio data link, each train establishes a "session" with each of the crossings along the line. The system verifies warning system health and operation as the train approaches the crossing. If proper functioning cannot be verified, the crossing becomes a target for the train control system and the train's speed is reduced to the extent possible.

[15] 49 CFR § 236.0 and §§ 501 et seq.
[16] 74 FR 35950, July 21, 2009.
[17] 63 FR 39343; July 22, 1998.

- FRA understands that the State of Illinois is also considering a feedback loop to the train control system that will verify that the four-quadrant gates on the Chicago-St. Louis designated HSR corridor are operating properly and that crossings are clear.

It should be noted that there is significant opposition within the rail community to the use of any technology that seeks to determine the presence of obstacles on highway-rail grade crossings and create any sort of feedback loop to the train. The opposition arises in part from the reality that today, motor vehicles often clear crossings only a few seconds before the arrival of the train. In order to be effective in providing warning to the train, the traffic control devices at the crossing would need to operate well ahead of the train's arrival, lengthening road-user dwell time significantly—which itself can erode compliance with the crossing warning system. Further, delivery of repeated false warnings to freight trains could lead to additional train handling challenges as well as significant fuel and emission costs.

However, where HSR passenger trains are present, it will be important for each crossing to be equipped with sealed corridor treatments. In most cases, there will be some portion of the crossing where presence detection is necessary to execute the sealed corridor strategy or is properly elected to deal with special challenges. Crossings with presence detection should be monitored by the train control system, and continued presence of obstacles following the expiration of the expected clearance timing should be communicated to high-speed passenger trains for action by the crew and the train control technology. FRA would not expect freight trains to be governed by this information unless route conditions indicate and the freight railroad so elects. Accordingly, this would be a function independent of the wayside signal system.

FRA will consider appropriate use of the train control system in reviewing grant applications, negotiating grant agreements, and reviewing filings under the PTC regulations. FRA will insist on integration of train control technology if any crossings are retained at speeds exceeding 110 mph.

Planners should note the potential project efficiencies that may be possible with effective train control integration. In addition to secure warning system pre-starts at higher speeds, train control might be configured to permit acceleration on approach circuits equipped with constant warning time circuitry (leaving stations and departing curves) to aid trip time.

6. Barrier Systems

The Track Safety Standards require that, at speeds exceeding 110 mph, "the railroad shall submit for FRA's approval a complete description of the proposed barrier/warning system to address the protection of highway traffic and high-speed trains."[18] The system must be approved and implemented before high-speed train operations may begin.

[18] 49 CFR § 213.347.

As speeds increase, there is a heightened concern with any condition that could result in a derailment. At times, mere warning to highway users is insufficient. Slick road surfaces, brake failures, stalled vehicles, motorist misperceptions, and other factors can result in vehicles going through gates just ahead of a train's arrival or vehicles becoming disabled on the crossing. Barrier systems, where required, need to meet the following tests to be effective:

- Barriers systems must operate in concert with the crossing warning system, and the combined system must provide critical information concerning system health and status to the train control system in real time.
- Barriers must be capable of stopping short of the crossing the heaviest motor vehicle operated on that roadway, taking into consideration the posted speed limit on the roadway.
- Barrier systems must include the capability to detect any object of significant obstruction (car, truck) that remains on the crossing after the barriers go into place.
- Barrier systems must communicate to approaching high-speed trains the presence of any significant obstruction in time for the train to reduce speed (i.e., to approximately 20 mph) or stop before reaching the crossing.

Through research and demonstration, FRA sought during the 1990s to determine the practicality and effectiveness of energy-absorbing barrier systems at highway-rail grade crossings. Those efforts were generally considered unsuccessful. FRA remains open to appropriate technology that is shown to be effective and reliable.

FRA is aware that barrier gates are in use at a small number of highway-rail grade crossings in the United States. These arrangements are suitable for low-speed roads and—together with presence detection—can add to the options available for improvement of HSR lines at speeds up to 110 mph. Under these circumstances, barrier gates deter violations and contribute to public awareness. However, presently marketed barrier gates do not address heavier motor vehicles and would therefore not be suitable without modification for protection of a rail line carrying trains above 110 mph.

7. Pedestrian and Trespass Considerations

High-speed passenger trains are difficult to detect visually and can be virtually silent until their arrival at any given location. Pedestrian treatments at vehicular crossings and associated sidewalks, including pedestrian pathways, are an essential safety element. Active warning directed at pedestrians should be provided, and warning system timing and the nature of the warning given should take into consideration special needs road users (e.g., the visually impaired or motorized wheelchair users). Channelization of pedestrian traffic is recommended to ensure that warning is effectively delivered and pedestrian behaviors are adequately cabined. Intercity and commuter railroads have implemented many innovative techniques that can significantly reduce hazards to pedestrians.[19] FRA is working with industry representatives and through the RSAC to refine strategies for controlling pedestrian movements in and around stations.

Crossings near stations pose special issues for persons with disabilities. Attention should be given to control of the flangeway gap in accordance with applicable standards.

Trespassing on railroad property is the single largest cause of deaths associated with railroad operations. HSR lines should be clearly posted against entry, and consideration should be given to use of tamper-resistant fencing, video surveillance, and similar measures in high-traffic areas. Control of trespassing is also essential to the reliability and security of HSR service.

8. Systems Approach

The Federal Highway Administration's *Railroad-Highway Grade Crossing Handbook* has long emphasized the importance of the systems approach to crossing safety. Although FRA regulations and this guidance document provide certain categorical requirements based on train speed, many areas of judgment remain. Planners should use the Handbook, the Technical Working Group report,[20] FRA's Collision Hazard Analysis Guide,[21] and reports from diagnostic team studies of conditions at individual crossings to make sound engineering judgments that may go well beyond the categorical criteria provided herein.

Crossing safety and trespass prevention should be further integrated in support of system planning and operation by its inclusion in System Safety Programs for HSR.

Project planning should incorporate strategies for: (1) educating road users concerning the onset of HSR service and making them aware of the inherent risks, and (2) gaining the support of law enforcement and the judiciary for strict application of traffic laws governing behavior at remaining highway-rail grade crossings. Public information and safety blitzes should be carried out at crossings and in communities prior to raising speeds by significant margins. Ongoing awareness efforts, including those directly addressed to commercial drivers serving facilities in the vicinity of the rail line, can help ensure familiarity with the crossing safety system and the importance of observing warnings.

The "system," of course, includes the railroad as well as the roadway. It should be emphasized that limiting train speed may be an available option to deal with a particularly difficult crossing. Hazard analyses should take into consideration the potential for second-

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[19] *See*, e.g., resources gathered at http://www.fra.dot.gov/us/content/1752; *ROW Fatality and Trespass Reduction Workshop 2008: Summary of Results* (DOT/FRA/ORS-09-001 February 2009) (available at http://www.fra.dot.gov/us/content/2232).

[20] *Guidance on Traffic Control Devices at Highway-Rail Grade Crossings* (report of the Highway-Rail Crossing Technical Working Group), FHWA (November 2002)(available at http://safety.fhwa.dot.gov/xings/collision/twgreport/).

[21] *Collision Hazard Analysis Guide: Commuter and Intercity Passenger Rail Service*, Office of Safety, FRA (October 2007) (available at http://www.fra.dot.gov/us/content/1785).

train collisions and for blocking crossings in a manner likely to present other challenges in the community (e.g., interfering with emergency response). Most often, these kinds of issues are best addressed at the design stage (i.e., initially as the project is planned or when a new facility, such as a passing track, is added). When safety is considered in project planning, capital can be used wisely to foster the best outcomes.

The Appendix provides a potential tier structure for passenger systems that have highway-rail grade crossings, and will provide a quick overview of issues to be considered in a systems approach.

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Conclusion

The safety of high-speed passenger systems is achieved only through proper planning, investment, operations and maintenance. Highway-rail grade crossings present major risks for train operations as well as for road users. As speeds increase, measures designed to reduce the frequency of crossing collisions must be strongly emphasized. Although FRA regulations provide minimum criteria for grade crossings on high-speed lines, including a prohibition of any at-grade crossings at speeds above 125 mph, responsible rail planners and railroads have gone well beyond those minimums, and technology has been demonstrated that has broader application. This document describes additional steps that should be taken to reduce risk and enhance the quality of HSR service.

Safety is FRA's paramount goal. In reviewing requests for funding for HSR FRA will actively apply this guidance.

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Appendix: Potential Tier Structure for Passenger Systems

Highway-Rail Grade Crossings

Tier	0	IA	IB	IC	II	III	IV	V
Description	**Regional Rail**	**Conventional**	**Emerging HSR**	**HSR Regional**	**HSR Mixed Operations**	**HSR Mixed Passenger**	**HSR Dedicated**	**HSR Express**
Max. Speed mph	**0-65**	**0-79**	**80-110**	**111-125**	**126-150**	**0-150**	**0-150**	**0-200/220**
Other traffic on same track	None (or temporally separated)	Mixed passenger and freight	Mixed passenger and freight	Mixed passenger and freight	Mixed passenger and freight	Conventional passenger only	None	None
Closures	Consolidation encouraged in regional and conventional service; funding condition if part of HSR corridor		Demonstrated effort and results required as part of funding process. No crossings above 125 mph				Grade separated – entire corridor	Grade separated – entire corridor
Public highway-rail grade crossings, generally	Automated warning; supplementary measures where warranted	Automated warning; supplementary measures where warranted	Sealed corridor; evaluate need for presence detection and PTC feedback	Barriers above 110, see §213.247 Presence detection tied to PTC above 110 mph	See IC None above 125 mph	See IC None above 125 mph	None at any speed	None at any speed
Private highway-rail grade crossings, generally	Automated warning or locked gate preferred; cross-buck and stop or yield sign where conditions permit	Automated warning or locked gate preferred; cross-buck and stop or yield sign where conditions permit	Automated warning with gates; or locked gate (interlocked with signal system at higher speeds)	None or as above	None above 125 mph	None above 125 mph	None at any speed	None at any speed
System Safety Programs	Crossing safety and trespass prevention issues included in SSP process.					Plus FRA reviews management decisions and may disapprove.		