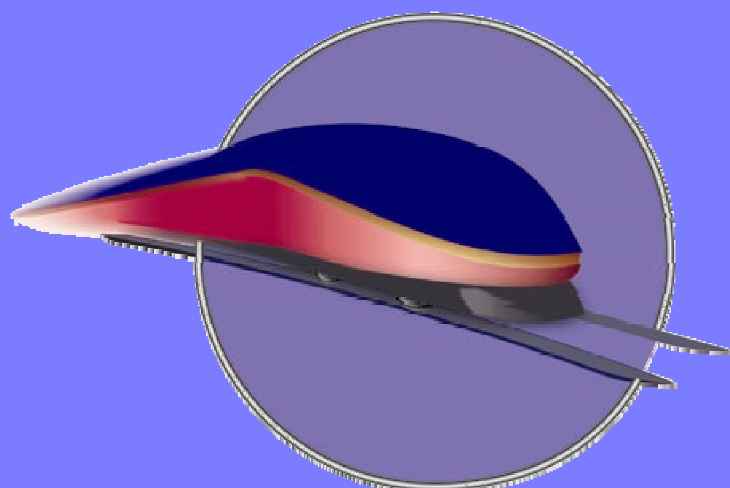
High-Speed Passenger Rail

Safety Strategy



Office of Railroad Safety
Office of Railroad Development

U.S. Department of Transportation
Federal Railroad Administration

Version 1.0
November 2009

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Preface to Version 1.0

The Federal Railroad Administration (FRA) initially issued the High-Speed Passenger Rail Safety Strategy (Strategy) on July 24, 2009. The first version was a Discussion Draft for Public Outreach. FRA distributed the Strategy to Rail Safety Advisory Committee participants and asked the industry to provide comments by August 28, 2009. Comments were received from 20 different organizations. All comments were reviewed and, where appropriate, incorporated in this, the final version of the High-Speed Passenger Rail Safety Strategy.

Many organizations commended FRA for developing a high-speed rail (HSR) strategy. They congratulated FRA for their proactive and progressive approach. The commenters acknowledged the vision that the Strategy provided and appreciated FRA providing a clear regulatory framework approach for the introduction of high-speed rail in the United States.

Other commenters provided advice on items that FRA should consider as they developed new rules or standards contemplated in the Strategy. Commenters were concerned with a variety of issues such as energy efficiency, train weights, and excessive axle loading and its affect on the viability of high-speed rail. Other commenters recommended methods to determine safety equivalency and encouraged FRA to use scientific risk management and safety cases in their evaluation of HSR equipment and systems. Still others offered to generously share information on train control systems, HSR equipment, and other technology from around the world that currently supports the safe and efficient operation of HSR systems. All the suggestions and offers for assistance are appreciated and will be considered as the Strategy moves forward.

The commenters were united in their desire to limit grade crossing exposure. Although FRA's current policy is to allow highway-rail grade crossings for train speeds up to 125 mph, some commenters asked that all grade crossings be eliminated at speeds above 110 mph. One commenter used the French approach as an example. The French ban grade crossings when train speeds reach 100 mph and enhance grade crossing equipment for corridors with train speeds between 80 and 100 mph.

Several commenters were concerned about commercial and legal issues. FRA received many questions regarding who pays and who is ultimately responsible for the operating concepts that FRA has discussed in the Strategy. Freight operators, for example, brought up several concerns related to sharing track and corridors with high-speed passenger rail. They remarked that infrastructure improvements and associated ongoing maintenance would be costly and risk and liability arising from passenger operations would amount to an unwarranted subsidy of passenger railroads. They also stated that constructing a dedicated right of way for high-speed passenger rail along an existing freight corridor would limit the ability of the freight railroad to access customers on the passenger rail side of the corridor. Freight railroads may also be affected by other obligations including requirements for right-of-way plans and real-time failure monitoring. Other commenters asked who would pay for improvements to grade crossings and other systems to support HSR.

Although these are important issues, they are primarily commercial issues that cannot be addressed in this Strategy. The appropriate method to settle these and other commercial or legal issues and to answer the questions posed here is through appropriate operating agreements between the freight operators and the passenger railroad. These requirements and potential affects on the freight railroad should not be overlooked when negotiating operating agreements.

Finally, some commenters requested that FRA expand the scope of the Strategy activities to cover additional subject areas including defining barrier treatments for separation of corridors, defining hazardous material and school bus route requirements, defining guidelines for perimeter protection, addressing protection of rail lines from vehicles falling from overpasses, and other safety-related activities. FRA agrees that these are valid concerns that deserve consideration. However, the Strategy presented here represents FRA's view of the most important elements that should be addressed immediately to support the development of HSR in the Nation. The other issues that have been offered are important but not as high a priority as the issues already identified in the Strategy. However, these and other issues may be added to the Strategy in the future as FRA begins to make progress on the most important initiatives.

Introduction

The History of High-Speed Rail

Fostering the development of high-speed rail (HSR) and other intercity passenger service in the United States has been an important part of the work of the Federal Railroad Administration (FRA) since its creation in 1967. During the 1980s and 1990s, FRA played a central role in managing and facilitating the growth of high-speed rail service on the Northeast Corridor. Acting in response to the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), FRA began the formal process of designating HSR corridors for future development and providing limited funding for corridor improvements directed primarily at safety. With the passage of the American Recovery and Reinvestment Act of 2009, which provided $8 billion in capital assistance for HSR corridors and intercity passenger rail service, and following President Obama's announcement of a strategic plan for high-speed rail ("*Vision for High-Speed Rail in America*"), FRA now takes on the important work of helping to make high-speed rail a reality in markets across the Nation.

Although the focus of this High-Speed Passenger Rail Strategy (Strategy) is developing HSR service on new corridors, inevitably this strategy needs to consider implications for other intercity passenger service, commuter rail service, and regional rail projects that seek to provide transit-like service on rail lines shared with conventional passenger or freight trains. Further, any HSR operation will include track segments where only conventional speeds are possible. Flexibility provided for the first time in connection with HSR may also be relevant to service at conventional speeds. Accordingly, other forms of passenger rail service are referenced to the extent necessary to attain consistency and clarity.

On June 17, 2009, FRA's Administrator issued a notice of funding availability and interim program guidance for the HSR and Intercity Passenger Rail Program (74 FR 29899; June 23, 2009). The guidance identified transportation safety and safety planning as evaluation criteria for merit consideration of proposed projects and programs. This Strategy describes how FRA will provide specificity and additional safety guidance for the development of HSR systems.

Safety and High-Speed Rail Going Forward

The hallmark of world-class, high-speed rail is safety. FRA believes that railroads conducting HSR operations in the United States can provide service as safe as, or safer than, any HSR operation being conducted elsewhere. FRA also believes that the expansion of HSR in America will yield safety benefits for those who choose to use the service instead of driving the same distance via roads and highways. Data published by the National Safety Council shows that, based on miles traveled, personal motor vehicle travel is 12 to 20 times more likely to result in a fatality than passenger rail travel.

In anticipation of such service, and to promote public safety, FRA has developed this Strategy, which includes: (1) establishing safety standards and program guidance for HSR,

(2) applying a system safety approach to address safety concerns on specific rail lines, and (3) ensuring that railroads involved in passenger train operations can effectively and efficiently manage train emergencies. This Strategy endeavors to achieve uniformly safe rail passenger service, regardless of speed. Since the severity of collisions and derailments increases with speed, safety performance targets for preventive measures are tiered to become more stringent as speed increases.

Current FRA regulations include Tier I equipment safety standards for passenger trains operating at speeds up to 125 mph. FRA established additional standards (Tier II) for high-speed trains that operate up to 150 mph. These Tier II requirements address crashworthiness, crash energy management, vehicle suspension systems, brake systems, train configurations and other elements critical for high-speed trainsets. The Tier II standards only impact the Amtrak Acela Service on the Northeast Corridor because Acela is currently the only Tier II application operating in the United States. Existing FRA track safety standards are comprehensive and specify track geometry and cant deficiency for FRA Classes 1 through 9 at speeds up to 200 mph. The track standards include requirements for Class 6 track (110 mph) and above for remote monitoring of carbody acceleration and truck hunting, and equipment qualification on actual routes. Appendix A provides a representation of current requirements and open issues related to track safety standards.

FRA is currently reviewing European and worldwide equipment standards and developing guidance for high-speed trains operating at up to 220 mph. FRA is also exploring improvements and expansions to vehicle and track safety standards through rulemaking. Currently, the agency is advancing rules that amend the Passenger Equipment Safety Standards and Track Safety Standards for high-speed train operations and train operations at high cant deficiencies to promote the safe interaction of rail vehicles with the track over which they operate. The rulemaking would revise the safety limits for these operations and the processes to qualify them, and account for a range of vehicle types. Although this rulemaking would substantially change FRA's regulations governing the safety of high-speed and high cant deficiency train operations, a number of the changes would codify FRA decisions affecting such operations made under current approval and waiver processes. It would therefore reduce some existing regulatory burdens while safely facilitating the broader introduction of high-speed operations and enabling lower-speed train operations to gain efficiencies through operation on curved track at higher cant deficiencies.

FRA will continue to promote safety and facilitate the introduction of new HSR operations. President Obama proposes to help address our new transportation challenges by investing in an efficient HSR network of 100- to 600-mile intercity corridors that connect communities across America. This vision builds on successful highway and aviation development models with a 21st century solution that focuses on a clean, energy-efficient option (even today's modest intercity passenger rail system consumes one-third less energy per passenger-mile than automobiles). FRA expects that each HSR operation will be appropriately tailored to its operating environment. The High-Speed Rail Strategic Plan divides potential operations into four categories or generic descriptions:

- HSR – Express. Frequent express service between major population centers 200–600 miles apart, with few intermediate stops. Top speeds of at least 150 mph on completely grade-separated, dedicated rights-of-way (with the possible exception of some shared track in terminal areas). Intended to relieve air and highway capacity constraints.
- HSR – Regional. Relatively frequent service between major and moderate population centers 100–500 miles apart, with some intermediate stops. Top speeds of 110–150 mph, grade-separated, with some dedicated and some shared track (using positive train control (PTC) technology). Intended to relieve highway and, to some extent, air capacity constraints.
- Emerging HSR. Developing corridors of 100–500 miles, with strong potential for future HSR Regional and/or Express service. Top speeds of up to 80–110 mph on primarily shared track (eventually using PTC technology), with advanced grade crossing protection or separation. Intended to develop the passenger rail market and provide some relief to other modes.
- Conventional Rail. Traditional intercity passenger rail services of more than 100 miles with as little as 1 to as many as 7–12 daily frequencies; may or may not have strong potential for future high-speed rail service. Top speeds of up to 79 mph generally on shared track. Intended to provide travel options and to develop the passenger rail market for further development in the future.

Additional strategies for mitigating risk will probably be necessary depending on the specific operating environment. FRA generic HSR definitions represent minimum baselines and do not preclude HSR operators, host railroads, or the FRA from defining additional appropriate requirements.

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Strategy

FRA currently administers a comprehensive set of safety standards for conventional and high-speed service. The standards include requirements for track, equipment, operating rules and practices, signals and train control, communications, emergency preparedness, certification of locomotive engineers and control of alcohol and drug use, among others. As HSR service expands, portions of those standards will require updating and augmenting. Going forward, FRA will also incorporate lessons learned from the work that has been underway on high-speed corridors since the enactment of ISTEA. This Strategy provides a framework for documenting lessons learned and integrating the necessary actions, and seeks to achieve the following purposes:

- Support a very high level of safety for new passenger rail service.
- Focus on safety results and flexibility to meet service needs while achieving those results.
- Ensure alignment between safety requirements and passenger rail funding policies.

To ensure adequate safety for HSR, FRA intends to utilize appropriate safety standards and to apply system safety program techniques to enhance safety while meeting transportation objectives.

FRA expects a significant increase in the number of HSR operations. Each HSR operation will operate in a different environment, and each will have different needs based on that environment. As a result, FRA anticipates a variety of proposed HSR operations that will consist of a combination of different types of equipment, different degrees of isolation from known hazards, and different safeguards. To maintain safety, FRA will need to have minimum safety standards or guidelines that apply clearly to a variety of operating environments, and a reliable method to assess the safety of a new operating environment. To allow FRA to more easily facilitate the evaluation and application of standards to specific operations, it will be helpful to group substantially similar operations together when possible. The four categories of HSR listed above can be used as a starting point for grouping similar operations. Additional factors that will be used to group similar operations include:

- The presence or absence of freight traffic, the volume of freight traffic, and the nature of freight operations (e.g., overhead vs. local switching).
- The degree to which passenger equipment used on the corridor(s) is of similar construction.
- The degree of isolation of the passenger system from other hazards (e.g., incursions of motor vehicles due to proximity of roads and bridges, the degree of security that can be established on the right-of-way, and the presence of natural hazards such as seismic events or high water).

Through this strategy, FRA proposes to define categories or "tiers" of rail passenger service tied to maximum operating speeds and the aforementioned factors. Safety requirements and guidance would then be matched to that structure. Appendix B provides a visual representation of how that might be accomplished.

1. Prevention

FRA already has a long history administering an extensive set of regulations designed to prevent accidents and injuries. These regulations address track, equipment, railroad operating rules and practices, qualification and certification of locomotive engineers, control of alcohol and drug use, and other subject matters. Forthcoming regulations will address bridge safety and medical fitness-for-duty of safety-critical employees, among other topics. However, there are specific additional refinements and actions that need to be taken to address the needs of HSR service.

a. Vehicle Track Interaction

The Track Safety Standards (49 CFR Part 213) specify requirements for nine classes of track based on maximum allowable speed. The standards for higher speeds focus on vehicle-track interaction as well as track geometry, rail integrity, and appropriate inspection practices. The Passenger Equipment Safety Standards (49 CFR Part 238) contain complementary requirements for qualification of high-speed passenger equipment. Based upon results of research and recommendations of the Railroad Safety Advisory Committee (RSAC), FRA is finalizing a proposed rule that would establish updated vehicle-track interaction safety standards, largely unifying the requirements in a single part of the Code of Federal Regulations and making it easier to qualify new equipment. The proposal would revise existing limits for vehicle response to track perturbations and add new limits where necessary. The proposal accounts for a range of vehicle types that are currently in use and may likely be used on future high-speed or high cant deficiency rail operations (or both) and provides safety assurance for train operations in all classes of track. The proposal is supported by the results of simulation studies designed to identify track geometry irregularities associated with unsafe wheel forces and acceleration, thorough reviews of vehicle qualification and revenue service test data, and consideration of international practices.

High-speed track safety standards are based on the principle that, to ensure safety, the interaction of the vehicles and the track over which they operate must be considered within a systems approach that provides for specific limits for vehicle response to track perturbation. From the outset, FRA strove to develop revisions that would serve as practical standards with sound physical and mathematical bases, account for a range of vehicle types that are currently used and may likely be used on future high-speed or high cant deficiency rail operations (or both), provide safety assurance for train operations in all classes of track, would not present an undue burden on operators, and would be verifiable by field measurements.

The proposed standards are based on safety principles that apply to trains of all speeds and cant deficiencies. For trains operating at higher speeds with greater cant deficiencies, the safety risk is increased. Accordingly, the application of the same safety principles to trains operating at higher speeds with greater cant deficiency will result in more stringent standards. FRA's proposal addresses the following key areas:

- Revise—
  - Qualification requirements for high-speed or high cant deficiency operations, or both.
  - Acceleration and wheel force safety limits.
  - Inspection, monitoring, and maintenance requirements.
  - Track geometry limits for high-speed operations.

- Establish—
  - Necessary safety limits for wheel profile and truck equalization.
  - Consistent requirements for high cant deficiency operations covering all track classes.
  - Additional track geometry requirements for cant deficiencies greater than 5 inches.

- Resolve and reconcile inconsistencies between the Track Safety Standards and Passenger Equipment Safety Standards, and between the lower- and higher-speed Track Safety Standards.

Through the close examination of these issues, the RSAC Task Force developed proposals intended to result in improved public safety while reducing the burden on the railroad industry where possible.

Although the RSAC Task Force did not recommend revising or retaining standards for Class 9 track, FRA has subsequently identified the continued need for benchmark standards addressing the highest speeds likely to be achieved by the most forward-looking potential HSR projects. To that end, FRA and Volpe have conducted additional research and vehicle-track interaction simulations at higher speeds and concluded that Class 9 track standards can be safely extended to include the highest contemplated speed proposed to date. FRA will include those benchmark standards in its forthcoming Notice of Proposed Rulemaking (NPRM) to revise the Track Safety Standards and continue discussions with the RSAC Task Force as comments are addressed. However, FRA intends that the Class 9 standards remain only as benchmarks with the understanding that the final suitability of track standards for HSR–Express will be determined only through examination of the entire operating concept, including the subject equipment, track, and other system attributes.

FRA will issue proposed and final rules on vehicle-track interaction and other key safety issues related to track and structures as soon as possible.

b. Positive Train Control

The Rail Safety Improvement Act of 2008 (RSIA)[1] reauthorizes and enhances FRA's safety programs. Notably, from an intercity passenger rail development perspective, the RSIA requires implementation of PTC[2] systems on every main line over which intercity rail passenger or commuter rail passenger service is regularly provided. Each Class I railroad carrier and each regularly scheduled intercity or commuter railroad must install PTC systems by December 31, 2015, governing operations on: (1) its main line over which intercity rail passenger or commuter rail passenger service is regularly provided, (2) its main line over which hazardous materials that are poisonous- or toxic-by-inhalation are transported, and (3) such other tracks as the Secretary designates by regulation or order. Addressing the practical requirements of this provision remains a financial challenge for passenger rail operators; however, it has always been understood that HSR requires very competent train control as an integral element of system planning and execution.

With help from the RSAC, FRA has prepared a proposed rule that will implement the RSIA PTC requirement.[3] Although PTC requirements are specified to support intercity and commuter passenger train service in all speed ranges, the proposed rule will address high-speed service (described as any service operating at speeds greater than 90 mph) in specific speed bands, with increased system capability required as operating speeds increase.

In anticipation of high-speed service—and to ensure public safety—FRA is proposing tiered requirements for PTC systems. The performance thresholds are intended to increase safety performance targets as the maximum speed limits increase to compensate for increased risks, including the potential frequency and adverse consequences of a collision or derailment. These requirements are cumulative as speeds increase. At speeds of 60 mph and above, the system would need to incorporate the safety-critical functions of a block signal system with fouling circuits and broken rail detection. For territories where operating speeds are greater than 90 mph, the PTC system must also be shown to be fail-safe (although comment will be solicited regarding the characteristics of onboard freight PTC equipment for Emerging HSR), and "perimeter protection" must be established to keep unauthorized movements (e.g., trains, unsecured rolling stock) off the railroad. The potential consequences of a collision or derailment for railroads operating above 125 mph are even greater. In addition to meeting the requirements under the previous two categories, such railroads exceeding 125 mph must also provide an additional safety analysis supporting the sufficiency of the PTC technology to support a level of safety comparable to similar transportation service and must include analyses demonstrating that opportunities for incursion into the right-of-way (e.g., vandalism, motor vehicles

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[1] Public Law No. 110-432, Division A, enacted Oct. 16, 2008.

[2] "Positive Train Control" means a system designed to prevent collisions between trains, overspeed derailments (derailments caused when a train exceeds speed limits), incursions into established work zone limits (i.e., for roadway workers maintaining track), and the movement of a train through an improperly positioned switch.

[3] 74 FR 35950; July 21, 2009.

deviating from adjacent roadways) have been addressed through prevention and/or detection and warning. (*See also* 49 CFR § 213.361 (Right-of-way plans for Class 8-9 track), discussed below.) The capability of PTC systems to provide detection and warning of incursions from trespassers or motor vehicles is an important feature that can assist a railroad to demonstrate an appropriate level of incursion protection. At speeds that exceed 150 mph, PTC functionalities would be described within an overall plan subject to FRA approval.

FRA will finalize standards for PTC systems by the end of November 2009.

c. Grade Crossing Safety

Highway-rail grade crossings pose inherent hazards to train operations, as they do to motor vehicles. Accordingly, existing FRA regulations require that train operations at greater than 110 mph be supported by plans designed to physically restrain motor vehicles from becoming a derailment hazard, and above 125 mph, no at-grade crossings are permitted (49 CFR § 213.347).

There have been demonstrated successes in deploying "sealed corridor" technology on designated HSR corridors. The most mature of these corridors is on the North Carolina Railroad, the route of intercity passenger service sponsored by the North Carolina Department of Transportation. U.S. Department of Transportation (DOT) grants and State funding have been used to eliminate unneeded crossings, channelize intersections, install four-quadrant gates, and demonstrate additional risk-reduction strategies. Work accomplished by North Carolina and States such as Illinois and Michigan charts the future direction for other HSR corridors, and data derived from quiet zones employing Supplementary Safety Measures supports that direction.

<u>The Sealed Corridor Study.</u> FRA's Office of Research and Development (R&D) tasked the Research and Innovative Technology Administration's (RITA) John A. Volpe National Transportation Systems Center (Volpe Center) to document the further success of the Sealed Corridor project through Phases I, II and III. The Sealed Corridor is the section of the designated Southeast High-Speed Rail Corridor that runs through North Carolina. The Sealed Corridor project improved or consolidated every highway-rail grade crossing, public and private, along the Charlotte-to-Raleigh rail route in North Carolina. The initial assessment of this HSR corridor as mandated by Congress was published in 2001. In 2008, FRA updated its assessment, comparing the results from a partial Phase I implementation to the results of completing Phases I, II, and III. The research on the Sealed Corridor assesses the progress made at the 189 crossings that have been treated with improved warning devices or closed between Charlotte and Raleigh from March 1995 through September 2004.

Two approaches are used to describe benefits in terms of "lives saved": (1) Fatal crash analysis to derive lives saved, and (2) prediction of lives saved based on the reduction of risk at the treated crossings. Both methods estimate that over 10 lives would be saved as a result of the 189 improvements implemented through December 2004. Analysis also shows that the resulting reduction in accidents due to the crossing improvements is sustainable through the year 2010, when anticipated exposure and train speeds along the corridor will be increased. In order to estimate future incident reduction rates and to estimate that the reduction result was sustainable, the Modified U.S. DOT Accident Prediction Formula was used to ensure that increases in train and vehicle exposure over time were considered in the analysis.

The resulting analysis estimated that the fatality rate resulting from full implementation of the entire sealed corridor would be half of the estimated fatality rate if no implementation was executed and speed increased to 110 mph.

Supplementary Safety Measures (SSMs). To maintain grade crossing safety when permitting quiet zones, Federal regulations require adding SSMs to the highway-rail grade crossings within the quiet zones. SSMs are deterrents; they are additional treatments that can be applied to grade crossings that will reduce the number of grade crossing violations. If adequate measures are taken to promote safety, high-speed rail operations, like quiet zones, will not compromise safety.

Proposed Policy. New high-speed rail operations will require enhanced grade crossing safety standards to maintain or enhance the level of safety demonstrated by conventional speed operations. To address the greater risks associated with higher train speeds, FRA has developed four safety principles:

1. Eliminate all redundant or unnecessary crossings together with any crossings that cannot be made safe due to crossing geometry or proximity of complex highway intersections.
2. Install the most sophisticated traffic control/warning devices compatible with the location (e.g., median barriers, special signage (possible active advanced warning), four-quadrant gates) where train-operating speeds are between 80 and 110 mph.
3. Protect rail movement with full width barriers capable of absorbing the impact of highway vehicles where train-operating speeds are between 111 and 125 mph.
4. Eliminate or grade-separate all crossings where trains travel at speeds above 125 mph.

In addition to aligning with the Track Safety Standards as referenced above, these principles are supported by FRA's Sealed Corridor Study, the School Street Study, and an equitable review of the effectiveness of SSMs required for quiet zones. Both the studies and the implementation of SSM for quiet zones address limited operational characteristics. FRA will be conducting further studies to confirm the effectiveness of these principles in additional operating environments.

Available technology may provide additional opportunities for risk reduction on high-speed corridors. For instance, Amtrak's Incremental Train Control System in Michigan provides a mechanism for each train to establish communication with each successive crossing to verify the health of the warning system and to verify that the crossing gates have descended. If a negative response or no response is received, the train experiences an enforcement that significantly reduces the speed prior to its arrival on the crossing. This system offers the additional advantage of providing a "pre-start" capability that compensates for increased train speed without needing to greatly extend train detection circuits.

On Amtrak's Northeast Corridor, four-quadrant gate installations with presence detection communicate with the cab signal system and cause a penalty brake application for the approaching train if a motor vehicle is detected on the crossing following the descent of the gates. This technology is plausible on the Northeast Corridor because of the relatively small number of crossings involved, the predominance of passenger traffic, and heavy rail traffic that supported the necessary investment.

The technology deployed in Michigan and on the Northeast Corridor offers significant advantages as well as challenges. On lines carrying long, heavy freight trains, care must be taken to ensure that the locomotive engineer remains in control of the train and that temporary obstructions do not lead to reactive braking that could cause undesirable in-train forces. Communications-based train control technology of the kind likely to be employed on Emerging HSR corridors could be arranged to meet these needs, but because most freight locomotives are used over extensive portions of the national rail system, interoperability would be a major concern.

Other approaches to reducing the risk posed by grade crossings on high-speed rail corridors also deserve consideration. Industry has suggested that limiting new crossings for corridors where train speed exceeds 110 mph may be appropriate, a suggestion underscored by the dearth of demonstrated safeguards. Other suggestions include placing a ceiling on the number of crossings per mile or requiring crossings to be closed when acceptable alternative crossings are available or when the crossings per mile exceed the standards. FRA intends to consider all of these suggestions as it moves forward with reviewing safety on HSR corridors. The ***Guidelines*** issued with this document will identify the apparent safety floor appropriate under the described circumstances. However, the discussion and identification of additional mitigations would likely be based on a case-by-case assessment and a system approach that considers the environment and all the features of the proposed system.

Coincident with issuance of this Strategy, FRA is providing initial ***Highway-Rail Crossing Guidelines for High-Speed Passenger Rail*** *that take into consideration stakeholder comments and will update and refine that guidance as further experience is acquired. FRA will also review the success of safety enhancements on designated HSR corridors in Illinois, Michigan, and Pennsylvania in connection with the Sealed Corridor Study and provide a report of the findings for use by those planning the details of HSR systems.*

d. Maintenance-of-Way Safety Management

FRA has given significant attention to Roadway Worker Protection, appropriately emphasizing the importance of providing for on-track safety for those inspecting and maintaining track and structures. The other aspect of this safety interface is ensuring that track is not disturbed ahead of train movements, that heavy on-track maintenance equipment is routed away from and kept clear of live tracks except when authorized to be there, and that maintenance equipment such as cranes that have the potential to foul live tracks during maintenance activities do not do so while trains are passing.

This issue is an important one on any railroad and, accordingly, is addressed in the operating and maintenance rules of the respective railroads. However, in HSR territory, the issue is even more important. HSR operations present additional risks to roadway workers because of the train speed and greater potential risk to workers on adjacent tracks. Adequate distance between track centers, or compensating safeguards, must be established to ensure employee safety for day-to-day work activities and decrease the chance of disruption. Existing railroad operation and maintenance rules may require adjustment to compensate for track curvature or geographic characteristics to further reduce any risk to workers. Integration of roadway worker safety and train control can create efficiencies that protect workers while preserving capacity.

For the present, safety systems such as PTC will not be sufficiently capable in most cases to address this type of hazard. Maintenance-of-way (MOW) equipment generally does not reliably shunt signal systems, and for the present, signal track circuits will be used by PTC to detect track occupancy and to stop trains short of equipment obstructing the track ahead. None of the railroads' current plans include equipping MOW equipment with PTC, although one freight railroad is utilizing a Hi-Rail Limits Compliance System for inspection vehicles that will be able to interface with PTC. Clearly, in developing PTC architectures for entirely new, dedicated HSR systems, attention should be given to identifying work equipment and personnel as "targets" to be protected by the PTC system.

The presence of MOW equipment either occupying the wrong track or fouling an adjacent track has been the cause of serious accidents in the past. If HSR is to be a success, more rigorous and effective means will be required to separate train operations from MOW activities. In corridors where there is dedicated passenger service, track maintenance will likely be scheduled during times in which no trains are operating, which will enhance safety.

FRA will develop guidelines for MOW safety management, which will be considered in reviewing system safety programs.

e. Right-of-Way Safety

Section 213.361 of the Track Safety Standards requires that, for Class 8 and 9 track (speeds exceeding 125 mph), the track owner must submit for approval a "right-of-way plan" for the prevention of—

(a) Vandalism

(b) Launching of objects from overhead bridges or structures into the path of trains

(c) Intrusion of vehicles from adjacent rights-of-way.

Although these requirements are fundamentally sound, they also apply at lesser speeds. Further, even at Class 8 and 9 speeds, questions will arise regarding what undertakings are fully responsive and appropriate. In addition, the existing provision does not refer to all relevant threats from outside the operating envelope.

Many HSR lines may be constructed in common corridors with freight or conventional passenger operations. Maintaining appropriate separation of the two forms of rail service will be critical, particularly where there is the potential for a freight train or its cargo to foul the high-speed track(s) or for a highway-rail grade crossing collision to cause a secondary impact between the high-speed train and other rail equipment. A variety of strategies can be brought to bear to mitigate these risks, all of which should be documented in a Right-of-Way (ROW) Safety Plan.

With the congestion in cities and the challenges associated with condemning property to build new rail lines, it is inevitable that some new railroads will share rights-of-way with interstate highways. For example, an HSR operation plans to share the Interstate 15 corridor from Victorville, California, to Las Vegas, Nevada, with train speeds up to 150 mph. As FRA works with this potential applicant for a waiver of passenger equipment structural standards, the agency has noted that there is little information available on how to safely integrate a highway system with a railroad system on the same right-of-way. The main issue is intrusion of highway vehicles on the railroad. (The issue is relevant beyond HSR as the New Mexico Rail Runner Express (Rail Runner) commuter rail operation between Albuquerque and Santa Fe, New Mexico uses the median of Interstate 25. The standards used for application of guardrails or other intrusion protection for Rail Runner are the same standards that the Federal Highway Administration uses when there is nothing in the median. In other words, there are no special provisions for a highway/railroad shared corridor. Rail Runner started service to Santa Fe in December 2008, and has already had some incidents. For instance, an automobile recently ended up on the tracks when the driver lost control while trying to avoid hitting a coyote.)

There is also a related issue involving highway overpasses. Even if all grade crossings are eliminated, there is still the risk of a car or truck falling from an overpass and landing on the track. The European railroads use intrusion detection nets and other devices on their

HSR lines to protect their rights-of-way at overpasses. In the United States, pedestrian pathways or bicycle trails are sometimes located along with existing rail corridors. Limitations on the location of these public access trails should also be addressed to restrict access to the HSR line and reduce risk from both safety and security perspectives. These strategies must be studied and evaluated. Intrusion mitigation techniques should be developed for incorporation into standards and eventually, into regulations.

Other issues involving external impacts on the operating environment include seismic events, high winds, high water, and landslides. These conditions are of greater or lesser interest depending upon site-specific factors and should be addressed expressly in an expanded ROW Safety Plan for each HSR system.

FRA will develop vehicle intrusion standards and standards for sharing rail/rail and highway/rail corridors for incorporation into regulations and/or funding guidance. FRA will detail additional hazards that must be evaluated and mitigated based on corridor-specific risks.

f. Real-Time System Monitoring

A variety of technologies are now available to monitor the health and performance of the railroad operating system in real time (continuously). Examples include onboard sensors, wayside detection devices and autonomous track geometry systems. These technologies should be evaluated for suitability in light of total residual risk as determined in system safety program planning.

FRA will develop an evaluation method to prompt thorough hazard analysis and mitigation planning for HSR systems.

2. Mitigation

a. Structural Standards

In the creation of an HSR network in the United States, it must be recognized that there are real differences between the American rail system and those found in other countries with HSR. Specifically, in the major countries that have pioneered HSR, the rail systems have traditionally been devoted primarily to passenger rail. As such, there are also three major characteristics that have made it easier to implement HSR systems in these countries. First, there have been fewer freight trains to deal with. Second, the freight trains (and particularly the motive power) are considerably smaller and lighter in weight than North American freight trains. Third, these rail systems do not have as many grade crossing issues: they have fewer highway-rail grade crossings (level crossings), the crossings are used by lighter trucks than those prevalent in the United States, and the respective populations have shown greater compliance with warning systems than is typically experienced in the United States.

Despite the differences noted above, FRA is in a good position to implement a sound safety regime for an HSR system. It is nevertheless important to recognize that while the North American freight network is the envy of the world, the fact that this network will also be the home of Emerging HSR and potentially more aggressive forms of HSR means that safety concerns will only increase if no action is taken to mitigate this risk.

This potential will be significantly reduced as PTC is deployed. To be sure, the need for reasonably crashworthy rolling stock remains an issue where local switching occurs, where multiple track operations create the potential for secondary collisions, where the potential for on-track maintenance vehicles to occupy live tracks exists, where MOW safety management cannot be fully guaranteed, and where highway-rail crossings remain that might be fouled by large trucks posing the potential for a derailment (with or without a secondary collision).

The Passenger Equipment Safety Standards presently describe only two tiers of equipment. Tier I equipment is equipment expected to be used in conventional passenger service, as well as HSR to 125 mph, on the general freight system. Tier II equipment is also designed for the general freight system, with speeds up to 150 mph. Many have noted that these standards are not aligned with service needs for higher-speed operations and for operations outside the freight network. Indeed, when FRA has been challenged to offer options for HSR–Express in the past, the agency has recognized the appropriateness of considering the type of equipment as an element in the larger operating system (see, e.g., notice of proposed rule of particular applicability for Florida Overland eXpress (FOX), 62 FR 65478, Dec. 12, 1997). That approach is characterized by the importation of the entire system in which the equipment operates for use in a wholly separate system, and not simply permitting noncompliant equipment to operate in a typical North American railroad setting. Unfortunately, the inability of successive HSR – Express projects to find stable funding has arrested development of a consistent approach to this challenge.

Since that timeframe, significant advances have occurred in numerical modeling, engineering design experience and fabrication techniques. Such advances currently allow for significantly enhanced engineering analyses to be conducted with the potential application to comprehensive performance standards that directly address mitigation of prevalent scenarios of concern for different types of operating environments. The key metrics of success of such standards are a minimum safe closing speed for which an impact can occur where no intrusion into the occupied volume is allowed, and the forces that crew members and passengers are subjected to are minimized to survivable levels.

Europe and Asia have embraced the use of hybrid performance and prescriptive standards for commuter railroads, intercity travel, and high-speed rail. International systems make use of complimentary risk reduction measures including advanced signal systems to provide for a high degree of collision avoidance with minimum levels of crashworthiness performance. FRA is currently assessing the variations in performance associated with several international passenger safety standards, advances in domestic specifications for new car procurements, and explanations for why such variations exist—such as significant differences in the operational environment and use of advanced collision avoidance technologies.

The present national commitment to high-speed rail brings with it a new opportunity to create greater predictability in how FRA will approach these issues. In order to identify opportunities for more closely tailored safety standards, FRA proposes to explore the possibility of describing a new tiered series of standards for the entire operating system, *including equipment*, in lieu of the current two-tiered structure that focuses on equipment only. These tiers could categorize methods of operation in conjunction with safety improvements such as separation of passenger and freight traffic and advanced train control systems. One of the challenges of a multi-tiered approach is downward compatibility of equipment. For example, would it be permissible to operate HSR express equipment at lower speeds without providing dedicated track and in the presence of highway-rail grade crossings? Configurations of equipment that may provide safe service at high speeds may not always provide safe operation in other environment. Therefore, FRA proposes to handle these anomalies on a case by case basis fully considering the environment and the attributes of the system. Therefore, operating authorities and car builders that wish to use alternatively designed equipment that cannot meet the current crashworthiness standards or new tier requirements will likely have to make use of the waiver process, but the structure for assessing equivalency of safety can be used as the means for removing the risk and uncertainty that such organizations otherwise would experience.

New tiered standards, or technical benchmarks to be used in lieu of standards, would describe a range of operating environments and, for each such environments, would specify—

- Basic end strength and crash energy management performance in longitudinal encounters.
- Other structural characteristics (e.g., side strength, roof strength as a function of vehicle weight).
- Fixture securement.
- Acceptable occupant accelerations and restraint strategies based on expected vehicle performance.

In order for this effort to be successful, FRA needs to complete its work on passenger car end strength as applied to conventional North American equipment designed for use on the general freight rail system. This amendment to the Passenger Equipment Safety Standards will complete the structural benchmarks against which other options can be evaluated. Based on an RSAC proposal and an FRA adaptation designed to provide greater design flexibility, FRA published a proposed rule on end strength on August 1, 2007 (72 FR 42016). The RSAC has made recommendations for a final rule that FRA will issue before the end of calendar year 2009.

FRA will finalize the pending cab end strength rule. FRA has initiated and will complete an effort within the RSAC to develop technical criteria and procedures for demonstrating that equipment built to alternative designs will provide safety equivalent to that provided by equipment compliant with Tier I standards under 49 CFR Part 238. Thereafter, FRA will examine the feasibility of codifying the criteria and procedures and describing additional tiers of equipment within the standards based on service conditions.

b. Cab Car Forward

New standards or guidelines could also address circumstances under which the use of passenger-occupied lead units may or may not be acceptable. FRA's regulations for Tier II operations, which covers passenger trains that operate up to 150 mph, requires that the power cars at the ends of the train exclude passengers. This is the current arrangement of the Acela trainset on the Northeast Corridor. One HSR operation that will be constructed on a dedicated right-of-way has proposed a 150 mph service with passenger seating in the power cars (cab cars). Another HSR operation has proposed a 220 mph service and has also included passenger seating in the power cars (cab cars).

FRA realizes that some of the more modern HSR train sets used overseas eliminate the conventional power car and use an electrical multiple-unit configuration that includes passenger seating in the cab car. However, there are no simple answers to the question of whether passenger seating in cab cars is appropriate. The answer will require careful research and full consideration of the operating environment where the trainset operates. Protection for the operator and passengers will remain a key factor.

FRA will conduct further research into the relationship between occupied power cars and the number of injuries and fatalities that might occur in a collision or derailment as part of this review.

c. Fuel Tank Integrity

Finally, some HSR projects may make use of diesel multiple-unit (DMU) rail cars. FRA's current fuel tank standards are derived from freight standards (49 CFR § 238.223), and arguments have been advanced that a more flexible approach should be taken for tanks positioned in such a way as to be better protected.

FRA will complete research into adaptation of fuel tank safety standards for self-powered DMU rail cars and propose tailored standards if warranted.

3. Emergency Management

All public transportation services rely on emergency preparedness and response to limit the adverse effects of accidents and other emergencies. In 1998, FRA issued a final rule on Passenger Train Emergency Preparedness (49 CFR Part 239), the declared purpose of which is to reduce the magnitude and severity of casualties in railroad operations by ensuring that railroads involved in passenger train operations can effectively and efficiently manage passenger train emergencies. Part 239 prescribes standards for the preparation, adoption, and implementation of emergency preparedness plans. Since that time, the RSAC and the American Public Transportation Association's Passenger Rail Equipment Safety Standards Task Force have generated a series of proposed and final standards and recommended practices to ensure that appropriate emergency systems and procedures are in place.[4]

FRA will publish a second NPRM based on RSAC recommendations concerning refinement of requirements for onboard emergency systems and finalize the rulemaking as soon as possible.

4. System Safety Programs

System safety programs (SSPs) seek to integrate the process of identifying safety needs and managing them over time. One key to success is effective hazard identification, which focuses attention on opportunities for risk reduction in the particular circumstances of the specific passenger railroad.

Working with the RSAC, FRA is drafting a proposed rule that will require each HSR, intercity, and commuter passenger railroad, together with any other railroads engaged in joint operations, to develop and implement a documented SSP. Host railroads, contract operators, shared track/corridor operators, and others who provide safety sensitive services to the operating railroads shall have defined roles in the passenger railroad SSP. The purpose of an SSP is to improve railroad safety through a structured, proactive program developed and implemented by passenger railroad operators. The program described in this section can support continuous safety improvement for passengers, employees and the public at large. The SSP can also support development of a strong safety culture and requires processes and procedures to identify and manage hazards inherent to the passenger railroad. The proposal would require the SSP to:

- Be defined and documented through a written System Safety Program Plan that meets the standards set forth in this section and is approved by FRA.
- Include hazard management processes designed to proactively identify, assess, and mitigate hazards before accidents occur.

[4] *See*, e.g., 73 FR 6370, Feb. 1, 2008 (Passenger Train Emergency Systems; Emergency Communication, Emergency Egress, and Rescue Access; Final Rule).

- Be fully implemented by the passenger railroad.
- Be audited for compliance by the passenger railroad and FRA or FRA's designee.

Generally, the SSP can be used in conjunction with minimum safety standards to increase safety. A system safety approach can bridge gaps in disciplinary knowledge and practice, completing the whole. For instance, station platforms are designed with capacity and accessibility in mind. However, straight platforms are also critical to managing the "gap," and passenger information and warning systems may be required to alert waiting passengers to the passage of high-speed express trains. Only by envisioning the operation of the high-speed railroad and considering the "what ifs" can initial system design provide the predicates for effective safety management.

Certain operations that are sufficiently isolated and present peculiar operation-related safety concerns may rely more heavily on a tailored system safety approach, particularly if a substantially similar operation exists and has operated safely. For example, in the late 1990s, FOX planned to utilize the French TGV ("train à grande vitesse" or "high-speed train") system in Florida. FRA's NPRM for FOX included a heavy reliance on SSP planning and management.

FRA will propose to require that scheduled passenger operations establish and maintain SSPs and include FRA review and approval of management decisions for HSR systems where it is necessary to determine an appropriate level of safety.

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Next Steps

In short, FRA believes that a modern HSR rail system that is safe both for riders and communities across the country, operating with an appropriate safety regime coupled with rigorous oversight, can become a reality.

More specifically, FRA will address prevention, mitigation, emergency management, and system safety integration through the steps set forth above. FRA will structure a new, tiered approach to passenger operations, taking into account maximum operating speeds as well as right-of-way characteristics, safety technology, planning requirements, and the presence or absence of less-compatible rail traffic (i.e., passenger equipment built to different standards or freight operations). As these actions are being completed, FRA will continue to respond to specific passenger rail projects by identifying the information and analysis required to evaluate and act on petitions for rules of particular applicability and waivers required to facilitate the introduction of innovative HSR service.

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Appendix A: Current Requirements and Open Issues

	80-110	111-125	126-150/160[1]	151-200+
Track	Class 5, 6[2]	Class 7	Class 8	Class 9
Passenger equipment	Tier I		Tier II	[Guidance needed]
Passenger-occupied vehicle leading	Permitted		Prohibited by 238.403(f)	[Guidance needed]
Signal and train control[3]	PTC – vitality and perimeter protection required above 90 mph		PTC – incursion strategy integrated	PTC – system safety plan integrated
Highway-rail grade crossings	[Guidance needed]	Barrier systems required under 213.247	Prohibited per 213.347	
MOW safety management	[Guidance needed]	[Guidance needed]	[Guidance needed]	[Guidance needed]
ROW incursion prevention / detection	[Guidance needed]	[Guidance needed]	Required 236.361	Required 236.361
System safety program	[Guidance needed]	[Guidance needed]	Subpart G, Part 238	[Guidance needed]

1/ The Track Safety Standards presently allow speeds to 160 mph for Class 8 track.
2/ The present track standards treat Class 6 speeds as the lower end of high-speed track. Cant deficiency qualification is easier at higher speeds than at lower speeds because of formalized procedures in place for high-speed track. This is under review.
3/ PTC final rule forthcoming.

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Appendix B: Potential Tier Structure for Passenger Systems

(Note: Common corridor issues handled within ROW Safety Plan review)

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**
Speed Range mph	**0-65**	**0-79**	**0- 80/110**	**0- 111/125**	**0-126/150**	**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
Track class	- Class 4	- Class 4	- Class 5/6	- Class 7	- Class 8	- Class 8	- Class 8	- Class 9
Signals, train control	Traffic control	PTC	PTC; vital and perimeter protection above 90	PTC; vital and perimeter protection above 90	Per IC and ROW safety strategy integrated			
Public highway-rail grade crossings	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	See IC None above 125	See IC None above 125	None at any speed	None at any speed
Private highway-rail grade crossings	Automated warning or manually locked gate preferred; cross-buck and stop or yield sign where conditions permit		Automated warning or locked gate with signal interlock	None or as above	None above 125	None above 125	None at any speed	None at any speed
ROW safety plan	System Safety Program / Collision Hazard Analysis				SSP/CHA and specific approval process for new service similar to 236.361			
MOW safety management plan	Address within SSP framework; no separate approval required				Separate plan approval; integrate with SSP/CHA			
Equipment	CEM – end frame strength dynamic test	Present Tier I plus Cab End Frame Strength, or equivalent safety (including option for alternative to buff strength)			Present Tier II (including option for alternative to buff strength)	See Tier IA-C	Define	Define
Occupied car forward	OK	OK			Prohibited	Up to 125 mph only	OK	Prohibited
On-board emergency systems	Per Parts 238 and 239 (including glazing, emergency egress and rescue access, lighting, signage, etc.)							
System Safety Programs	Required; Review is for completeness; Audits for follow through				Integrate Subpart G, Part 238	Required; FRA reviews management decisions and may disapprove		