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COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
SUBCOMMITTEE ON RAILROADS, PIPELINES AND HAZARDOUS MATERIALS

OVERSIGHT OF POSITIVE TRAIN CONTROL IMPLEMENTATION IN THE UNITED STATES

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On behalf of the Association of American Railroads (AAR), thank you for the opportunity to discuss positive train control (PTC). AAR members account for the vast majority of North American freight railroad mileage, employees, and revenue.

In this testimony, I will review what positive train control is and what it is meant to do; the progress railroads have made in the development and implementation of this technology; and what to expect going forward. While other railroad entities use each Class I railroad's tracks — Amtrak, commuter railroads, and shortlines — my focus will be on Class I freight railroads and their PTC operations.

The bottom line is that by December 31, 2018, all Class Is will have completed PTC installation, just as Congress required. Further, by the end of this year PTC will be in operation on the vast majority — approximately 80 percent — of Class I PTC route-miles network wide, with some Class I railroads planning to be fully implemented on their networks. Between 2018 and 2020, the remaining Class I railroads will be completing PTC implementation, consistent with the statute. All railroads will continue their work on resolving technical operational challenges that will inevitably rise, which Congress anticipated and specifically provided protection for in its 2015 law. They also will be addressing perhaps the biggest challenge of PTC implementation: interoperability with each other and with their tenant passenger and shortline railroads.

What is Positive Train Control?

"Positive train control" (PTC) describes technologies designed to automatically stop a train before certain accidents caused by human error occur. Under the Rail Safety Improvement

Act of 2008 (RSIA), passenger railroads and Class I freight railroads are required to install PTC on main lines used to transport passengers or toxic-by-inhalation (TIH) materials.[1]

Specifically, PTC as mandated by the RSIA must be designed to prevent four major types of train accidents: train-to-train collisions; derailments caused by excessive speed; unauthorized incursions by trains onto sections of track where maintenance activities are taking place; and the movement of a train through a track switch left in the wrong position.[2] The PTC system now being installed to meet this statutory mandate is an overlay system, designed to be failsafe and meant to supplement, rather than replace, existing methods of operation.

Positive Train Control is an Unprecedented Technological Challenge

To work as it should, a PTC system must be able to determine the precise location, direction, and speed of trains; warn train operators of potential problems; and take immediate action if the operator fails to act after a warning is provided by the PTC system. For example, if a train operator fails to begin stopping a train before a stop signal or slowing down for a speed-restricted area, the PTC system will override the operator and apply the brakes automatically before the train passes the stop signal or enters the speed-restricted area.

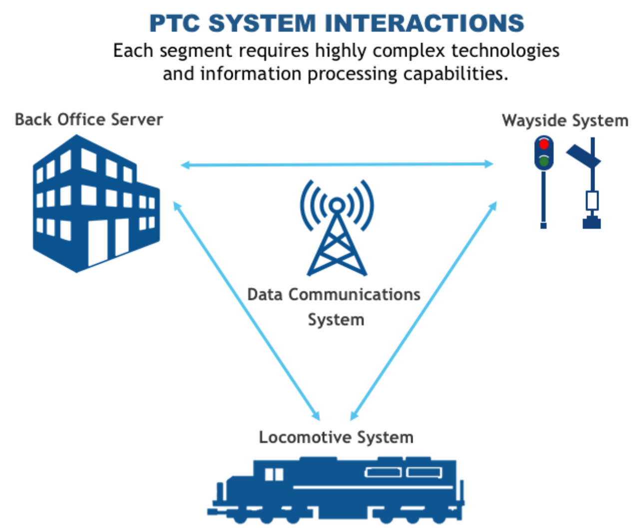
A PTC system consists of three main elements that are integrated by a fourth critical element, the wireless data communications system. An *onboard or locomotive system* monitors a train's position and speed and activates braking as necessary to enforce speed restrictions and unauthorized train movements; a *wayside system* monitors railroad track signals, switches, and track circuits to communicate data on this local infrastructure needed to permit the onboard

[1] TIH materials are gases or liquids, such as chlorine and anhydrous ammonia, which are especially hazardous if released into the atmosphere.

[2] A switch is the infrastructure that controls the path of trains where two sets of tracks diverge or converge.

system to authorize movement of a locomotive; and a *back office server* stores all information related to the rail network and trains operating across it (e.g., speed restrictions, movement authorities, train compositions, etc.) and transmits this information to individual locomotive onboard enforcement systems. Finally, all of these are integrated by a *wireless data communications system* that must move massive amounts of information back and forth between the back office servers, the wayside equipment, and the locomotive's on-board computers.

FIGURE 1



Such a system requires highly complex technologies able to analyze and incorporate the huge number of variables that affect train operations. A simple example: the length of time it takes to stop a freight train depends on train speed, terrain, the weight and length of the train, the number and distribution of locomotives and loaded and empty freight cars on the train, and other factors. During the operation of a single train over a single operating segment of track known as a sub-division, the length of time and the distance needed to stop that train may change 100 or more times due to changes in the factors mentioned above. A PTC system must be able to take all of these factors into account automatically, reliably, accurately and in real time in order to safely stop the train wherever it may be along its route.

PTC development and implementation constitute an unprecedented technological challenge. Some of the development and installation tasks associated with the Class I railroads' efforts include:

- ✓ A complete physical survey and highly precise geo-mapping of the more than 54,000 route-miles on which PTC technology will be installed, including more than 450,000 field assets along the right-of-way (e.g., mileposts, curves, rail and highway grade crossings, switches, signals, track vertical profiles and horizontal geometry).
- ✓ Installing more than 28,500 custom-designed "wayside interface units" (WIU) that provide the mechanism for transmitting information from signal and switch locations along the right-of-way to locomotives and railroad facilities.
- ✓ Installing PTC technology on more than 17,200 Class I locomotives[3].
- ✓ Installing PTC technology on nearly 2,100 switches in non-signaled territory and completing signal replacement projects, including upgrades to PTC-compatible signal technology, at some 14,500 locations.
- ✓ Developing, producing, and deploying a new radio system specifically designed for the massive data transmission requirements of PTC at tens of thousands of base stations and trackside locations, and on more than 17,200 locomotives.
- ✓ Developing back office systems and upgrading and integrating dispatching software to incorporate the data and precision required for PTC systems.

In all these areas, Class I railroads have already made tremendous progress. Figure 2 has details on the status of Class I PTC installations at the end of 2017.

FIGURE 2
CLASS I FREIGHT RAILROAD PTC INSTALLATION AS OF DEC. 31, 2017

Locomotives			Wayside Interface Units		
Equipped and PTC Operable	Required for PTC Operation	% Complete	Installed	Required	% Complete
13,470	17,261	78%	26,698	28,604	93%

Employees			Radio Towers		
Trained	Require Training	% Complete	Installed	Required	% Complete
88,556	101,821	87%	14,667	15,067	97%

Source: AAR compilation of figures provided by individual Class I railroads

[3] As just one example of the magnitude of the PTC implementation effort, on average it takes one person working for one month to install all of the necessary PTC equipment on a single locomotive. It will take approximately 1,400 staff-years to install PTC on all of the Class I locomotives that require it.

Additionally, as shown in Figure 3, at the end of 2017, the Class I railroads already had in operation more than 30,000 route-miles, or 56 percent, of the 54,000 route-miles that will eventually be equipped with PTC. To be clear, each Class I railroad will install 100 percent of PTC wayside, back office, and locomotive hardware and complete all required training by the end of 2018 and Class I railroads collectively expect to have nearly 80 percent of required PTC route-miles operational network wide by the end of 2018.

FIGURE 3

CLASS I FREIGHT RAILROAD PTC IN OPERATION AS OF DEC. 31, 2017

Miles		
In PTC Operation	Required for PTC Operation	% Complete
30,223	54,028	56%

Source: AAR compilation of figures provided by individual Class I railroads

The AAR estimates that, as of the end of 2017, freight railroads together have spent more than $8 billion — of their own funds, not taxpayer funds — on PTC development and deployment, and expect to spend more than $10 billion by the time PTC is fully operational nationwide. This does not include the hundreds of millions of additional dollars needed each year to maintain the railroads' PTC systems once they are initially installed.

Testing and Validation is Essential for Safe Operation and Full Interoperability

From the outset, railroads' efforts were focused on development and testing of technology that could meet the requirements of the RSIA, particularly those related to interoperability, and that could be scaled to the huge requirements of a nationwide system. For example, production and installation of the new radios — necessary to meet PTC's immense communication demands — became possible only after a long period of development and testing. Essential software and hardware for many PTC components had to be developed and deployed, and then rigorously tested. Only after technology is actually installed and exposed to the rigors of day-to-day operations can the task of testing each of the individual parts, and the system as a whole, be completed under real world conditions.

This task is made particularly complex by the need to ensure that PTC systems are fully and seamlessly interoperable across all of the nation's major railroads. It is not unusual for one railroad's locomotives to operate on another railroad's tracks. When that happens, the "tenant" locomotives must be able to communicate with, and respond to conditions on, the "host" PTC system. Put another way, a CSX locomotive must behave like a Norfolk Southern locomotive when it is traveling on NS track; a BNSF locomotive must be compatible with Union Pacific's PTC system when it is on UP track, and so on. All the while, each railroad has its own operating rules designed to address specific conditions on its property, all consistent with FRA regulations, but further adding to this complexity. Ensuring this interoperability has been a significant challenge.

Interoperability appears to also have been a significant problem in Europe where the European Union's first "interoperability directive" was published in 2001. It was not until 2016 that sufficient technical progress in either hardware or software had been made to allow the first deployment of an early stage, interoperable system. However, much work remains to be done to cure both technical and institutional problems that keep their current technology from being fully equivalent to that required under U.S. statute. To date, only 2,400 miles of track in the EU are equipped with this new generation technology. The EU does not expect that a 30,000-mile “core” network will be deployed before 2030; a full build out over 73,000 miles of the most densely used portions of the European network is not expected to be completed before 2050[4,5].

It is critical that the huge number of potential failure points in PTC systems be identified, isolated, and corrected. By necessity, a mature, well-functioning PTC system is enormously complex, and it is not realistic to think it will perform flawlessly day in and day out, especially upon initial implementation. That is precisely why testing, first in a simulated environment and then under real-world operating conditions, is so important. Unfortunately, the failure of a single part within a complex PTC system can mean the system does not work as it should. When that happens, the fail-safe nature of PTC means that trains are not able to operate normally on affected rail lines until the failure is corrected, a situation railroads are facing today as they proceed toward PTC implementation. U.S. railroads are working hard to limit negative impacts on their customers associated with PTC rollouts, but these impacts will be a fact of rail life particularly until the system fully matures.

Every day, as railroads finalize their PTC installation and expand PTC operations, additional accident avoidance becomes possible. However, as other train control systems implemented in other countries demonstrate, there is risk in improperly designed, installed, or operated PTC systems. This is not just a speculative concern. Since 2008, there have been a number of incidents worldwide in which accidents resulting in deaths and injuries occurred on

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[4] European Court of Auditors, Special Report No. 13, A Single European Rail Traffic Management System: Will the Political Choice Ever Become Reality? European Union, Luxembourg, July 2017.

[5] European Commission, Delivering an Effective and Interoperable European Rail Traffic Management System (ERTMS) – The Way Ahead, Commission Staff Working Document, Brussels, November 2017.

rail lines that had PTC-like systems. Insufficient testing of PTC design or equipment has been identified as the cause in two high profile accidents involving significant fatalities[6,7]. These concerns make it essential that a railroad's first priority must be to implement PTC correctly, and to test and validate it thoroughly.

Conclusion

Railroads have devoted enormous human and financial resources to develop a functioning and reliable PTC system, and progress to date has been substantial. Class I railroads remain committed to safely implementing PTC as quickly as feasible. By the end of 2018, each Class I railroad will have implemented PTC or initiated revenue service demonstration on, at a minimum, 51 percent of its required PTC route-miles or subdivisions; have 100 percent of the necessary wayside, back office, and locomotive hardware installations completed; have all required spectrum in place; and have all required employee training completed.

In addition, network-wide, approximately 80 percent of required PTC route-miles are expected to be operational by the end of 2018. While several Class I railroads plan to be fully implemented by the end of this year, all Class I railroads will be fully implemented no later than 2020. In the meantime, Class I railroads will continue to work with each other and their tenant

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[6] In 2011 a pair of trains on a high-speed line in China equipped with a PTC-like system collided, resulting in 40 deaths and 192 injuries. Investigation of cause revealed that installation of a Japanese "off-the-shelf" PTC-like system failed to recognize and adjust for local operating conditions and rules and was not properly adapted to the dispatching and train management processes used on the Chinese line.

[7] In 2013 a high-speed train in Spain derailed while exceeding the speed limit on a sharp curve at the end of the high-speed section of the railway, killing 79 passengers and injuring 139. The high-speed portion of the route was equipped with a PTC-like system, but failed to warn the locomotive engineer of the speed-restricted curve and also failed to take action to slow the train. Investigation of cause determined that the failure of the system to intercede was due to both design flaws and a failure of the operational components of the system.

passenger and shortline railroad partners to successfully achieve full interoperability – the largest remaining challenge to a fully implemented national PTC system.