Positive Train Control (PTC)

ASSOCIATION OF AMERICAN RAILROADS JANUARY 2019

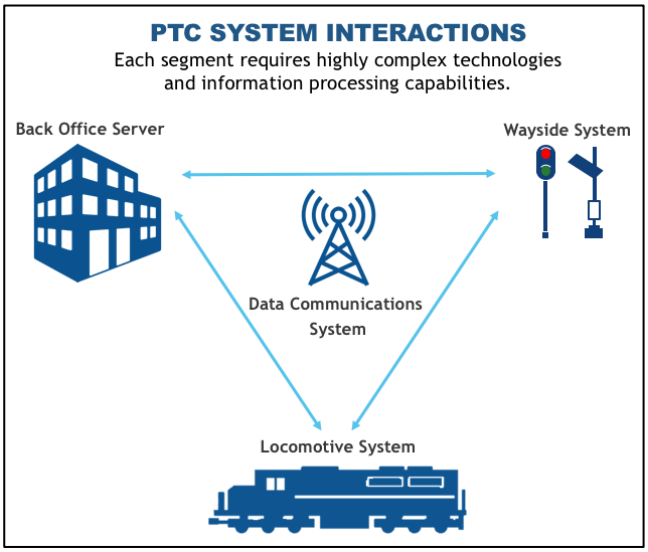
Summary

The seven U.S. Class I freight railroads are committed to safely implementing positive train control as quickly as feasible. They all met statutory requirements by having 100 percent of their required PTC-related hardware installed, 100 percent of PTC-related spectrum in place, and 100 percent of the required employee training completed by the end of 2018. In aggregate, Class I railroads had 83 percent of required PTC route-miles operational at the end of 2018, well above the 50 percent required by statute. Two Class I railroads were operating trains in PTC mode on all of their PTC routes at the end of 2018; each Class I railroad expects to be operating trains in PTC mode on all their PTC routes no later than 2020, as required by statute. In the meantime, railroads are continuing to test and validate their systems thoroughly to ensure they work as they should. Every day, as railroads expand PTC operations, additional accident avoidance becomes possible.

What is Positive Train Control?

- "Positive train control" describes technologies designed to automatically stop a train before certain accidents caused by human error occur. Specifically, PTC as mandated by Congress must be designed to prevent 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.
- The Rail Safety Improvement Act of 2008 originally called for passenger railroads and Class I freight railroads to install PTC by the end of 2015 on mainlines used to transport passengers or toxic-by-inhalation (TIH) materials. In October 2015, the statutory deadline for PTC installation was extended to the end of 2018, with further extensions available up to the end of 2020 to allow time for railroads to adequately test their systems.
- A PTC system consists of three main elements:
  - ✓ An *onboard or locomotive system* monitors a train's position and speed and activates brakes as necessary to enforce speed restrictions and prevent 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 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.

- These three elements 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.



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 from the PTC system. For example, if a train operator fails to begin stopping a train before a stop signal, the PTC system will apply the brakes automatically before the train passes the stop signal.

- Such a system requires highly complex technologies able to analyze and incorporate the huge number of variables that affect train operations. A simple example: how long it takes to stop a train depends on train speed, terrain, the weight and length of the train, the number and distribution of locomotives and freight cars on the train, and other factors. A PTC system must be able to take all these factors into account automatically, reliably, accurately and in real time in order to safely stop the train wherever it is along its route.

- **PTC development and implementation has been an unprecedented technological challenge**, on a scale never attempted on railroads anywhere in the world. Necessary tasks for Class I freight railroads include:

  - ✓ A complete physical survey and highly precise geo-mapping of the nearly 54,000 freight 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 nearly 16,400 locomotives.
  - ✓ 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 nearly 16,400 locomotives.
  - ✓ Upgrading some 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 back office systems and upgrading and integrating dispatching software to incorporate the data and precision required for PTC systems.

- Thanks to the enormous human and financial resources they devoted to the effort, Class I railroads have met all 2018 PTC-related statutory requirements. As of the end of 2018, PTC was operational on 44,695 miles, or 83 percent, of the 53,732 route-miles that will eventually be equipped with PTC. Moreover, each Class I railroad installed 100 percent of PTC wayside, back office, and locomotive hardware, and completed all required employee training, by the end of 2018, as statute required.

- As of the end of 2018, Class I freight railroads in aggregate had spent $10.6 billion — their own funds, not taxpayer funds — on PTC development and deployment. Maintaining the PTC systems once they are installed will cost hundreds of millions of additional dollars each year.

U.S. CLASS I FREIGHT RAILROAD PTC INSTALLATION AS OF DEC. 31, 2018

Locomotives

Equipped and PTC Operable	Required for PTC Operation	% Complete
17,160	16,375	105%

Employees

Trained	Require Training	% Complete
100,932	92,929	109%

Radio Towers

Installed	Required	% Complete
14,912	14,912	100%

Route-Miles

Installed	Required	% Complete
44,695	53,732	83%

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

Testing and Validation is Essential

- From the outset, railroads' PTC efforts have been focused on development and testing of technology that could meet the requirements of the RSIA and that could be scaled to the huge requirements of a nationwide system. Essential software and hardware for many PTC components has had to be developed from scratch, then deployed and rigorously tested. Only after technology is actually installed and exposed to the rigors of day-to-day rail 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. Ensuring this interoperability has been a significant challenge.

- 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. Railroads' first priority must be to implement PTC correctly, and to test and validate it thoroughly.