UNION PACIFIC'S
Positive Train Control Update

UNION PACIFIC
BUILDING AMERICA®

760
BASE RADIO TOWERS INSTALLED

MORE THAN
800
TRACK MILES IN REVENUE SERVICE DEMONSTRATION (RSD) OPERATION

3,212
ON-BOARD COMPUTERS INSTALLED

4,658
COMPUTER DISPLAYS INSTALLED

3,212
LOCOMOTIVE RADIOS INSTALLED

BUILDING AMERICA® UNION PACIFIC

8000

5,656 LOCOMOTIVES REQUIRING PTC INSTALLATION

- **17%** Need Equipped
- **26%** Partially Equipped
- **57%** Fully Equipped*
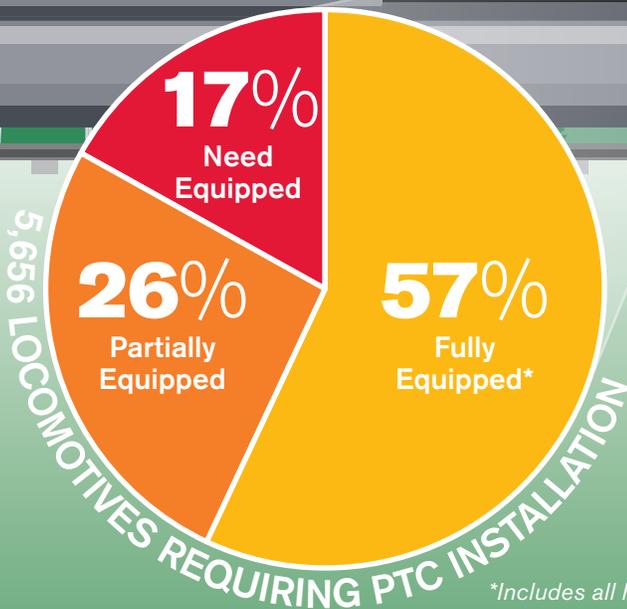
WHAT PTC DOES

☑ Automatically stops a train before certain accidents caused by human error occur, including train-to-train collisions, derailments caused by excessive train speed, unauthorized train entry into work zones or movements through misaligned track switches.

☒ Will not prevent vehicle-train accidents at railroad crossings, stop trains when pedestrians are on the tracks, or prevent incidents due to track or equipment malfunctions.

Includes all hardware except the PTC-compatible, crash-hardened memory ('black box')

OCTOBER 2016 SYSTEM UPDATE

Developing and implementing a PTC system is a multi-dimensional process requiring a cross-functional, networkwide approach. Union Pacific's PTC system consists of multiple technologies functioning together to constantly monitor and manage train movements. These involve integration of signal and telecom elements; GPS; wayside, base station and locomotive radios; antennas and satellites – all to predict whether the train crew should be alerted to take action or take over control to slow or stop the train.

Through Sept. 1, 2016, Union Pacific:

- Invested $2.1 billion in PTC. Union Pacific's current estimate for PTC's total cost is about $2.9 billion.

- Installed 88 percent, or 15,271 miles, of total route miles with PTC signal hardware.

- Partially installed PTC hardware on about 83 percent of its 5,656 locomotives earmarked for the technology.

- Equipped 2,016 locomotives with PTC hardware and software for revenue service demonstration (a test of the PTC system in a defined rail corridor).

- Installed 84 percent of the wayside antennas needed to support PTC along the company's right of way.

40 PTC TRAINS PER DAY OPERATING IN THE L.A. BASIN AND CENTRAL CALIFORNIA

Operations Underway Across 800 Miles in California

Union Pacific freight trains with PTC-equipped locomotives and PTC-trained crews began operating in California in late 2015. Classified as "revenue service demonstration" or RSD, the locomotives, equipment and crews are in operational testing for safety compliance, a monumental undertaking across all PTC components and service groups. On any given day, around 40 trains are operating in southern California's L.A. Basin. This RSD service allows Union Pacific to continuously refine its implementation of this built-from-scratch technology and gather feedback, such as:

- verifying and enhancing track feature databases;

- improving educational tools for train crews;

- standardizing engineering and dispatching processes; and

- continuing to assess locomotive reliability.

MORE THAN
800
TRACK MILES IN REVENUE
SERVICE DEMONSTRATION
(RSD) OPERATION

HOW PTC WORKS

BRAKING IN PROGRESS

SIGNAL

Using GPS, PTC evaluates train's distance from end of authority limits

Warning given if engineer doesn't slow train

PTC triggers brakes if engineer doesn't brake to stop short of limits