ABCs of Positive Train Control (PTC)

ASLRRRA – PTC Symposium
April 27th, 2013
Why PTC?

Over the last four decades, the National Transportation Safety Board (NTSB) has investigated a long list of accidents in which crew members failed to operate their trains effectively and in accordance with operating rules.

Because of these human performance deficiencies, the NTSB has advocated for systems that would compensate for human error and prevent train collisions.
PTC Regulatory History


1996: FRA establishes a Railroad Safety Advisory Committee (RSAC) to develop recommendations on safety issues. RSAC includes reps from all major rail safety stakeholders (FRA, rail labor and management, suppliers).

September 1997: An RSAC PTC Working Group is formed to develop regulations for PTC.
1999: RSAC provides FRA with a consensus report defining the PTC core functions to include:

- Prevention of train-to-train collisions
- Enforcement of speed restrictions
- Protection for Roadway Workers

March 7, 2005: These core PTC functions are codified into regulations for voluntary installation of PTC systems known as 49 CFR 236 Subpart H.
Two major railroad accidents (2005 at Graniteville, South Carolina and 2008 at Chatsworth, California) were cited as PTC preventable accidents during Congressional hearings that resulted in legislation leading to the unfunded PTC mandate.

- **Graniteville, 1/6/2005:** A Norfolk Southern train was diverted through a manual switch improperly lined for main track movement and collided with a parked train. 44 cars derailed including three tank cars containing chlorine gas. One tank breached releasing 60 tons of gas. Fatalities – 8; Injuries - 500+; Evacuated 5,400 people for two weeks; Cost - $190+ Million.
Why Mandatory PTC Regulations?

- **Chatsworth, 9/12/2008:** A *Metrolink* train passed a “red” signal while the engineer was texting, entering a single main track where a UP freight train was authorized to operate. The trains collided. Fatalities – 25; Injuries - 130+ serious; Cost - $200 million, met the federal passenger rail liability cap.
2008 Rail Safety Improvement Act: Who must implement PTC?

Act mandates a PTC Implementation Plan with a December 31, 2015 implementation for:

1) Class I railroad carriers; and

2) each entity providing regularly scheduled intercity or commuter rail passenger transportation (i.e. ARRC)

And the PTC must govern operations on:

a. Mainline used for passenger/commuter rail transport
b. Mainline used by hazmat freight transport
c. Other tracks prescribed by regulation or order
Operating in PTC Territory?

A train operating on any track segment equipped with a PTC system shall be controlled by a locomotive equipped with PTC that is fully operative and functioning.

Now the 236.1006 (b) (4) exceptions for Class II or III railroad, including a tourist and excursion railroad, without onboard locomotive PTC to operate on PTC-operated track, IF ALLOWED BY A HOST RAILROAD:

i. Either:
   A. No passenger trains; or
   B. Has passenger trains and PTCIP permits a Class II or III train to be operated;
Operating in PTC Territory? (cont.)

ii. Operations are restricted to four or less unequipped trains per day (a “turn” counts as two train movements); and

iii. Each movement shall:
   A. Limit to 20 miles; or
   B. Any movement over 20 miles after 12/31, 2020 require equipping the train with PTC.

All movements made under this exception will be limited in to the 236.1029 (b) enroute failure rules.

Reach agreement with the HOST railroad NOW if you have not done so yet.
2010 regulations require PTC systems to **reliably** and **functionally** prevent:

1) **Train-to-train collisions** by enforcing authority limits
2) **Overspeed derailments**
3) **Incursions into established work zone limits**
4) **Train movement through a main line switch** in the **improper position**. *(This provision was added to the 2005 PTC regulations Subpart H and after ARRC started its PTC implementation.)*
PTC is NOT designed to protect against derailments caused by, among other things:

- **equipment failures** such as broken wheels, pulled drawbars and seized journals;
- **infrastructure conditions** such as washouts, rock slides and some broken rails and heat kinks; and
- **external factors** such as grade crossing accidents or deliberate vandalism.
What if a RR fails to Comply?

Federal law provides penalties for non-compliance:

- FRA authority to fine 61 different PTC-related violations.
- Fines begin for activities 90 days after regulations were final in 2010.
- Maximum FRA fine for failure to complete PTC installation by December 31, 2015, is $16,000 per violation and $25,000 for each “willful” violation. A separate violation is issued for each day the violation occurs.
- FRA rail safety law compliance pertains to “persons” so both the corporation and individuals are on the hook.
PTC Deadline Extension Status

- A Moving Target: Regulations still being written by FRA affecting cost and implementation planning – ARRC’s participation in FRA and AAR committees vital
- Railroads will not make the 2015 deadline
- Organizations all support extension of the deadline (some three years, some five years)
- Alaska Railroad making “good faith effort” to implement PTC
PTC System Overview

PTC On-Board Equipment
- Human-Machine Interface Display
- Train Management Computer (TMC)
- Location Determination System
- Digital Radio

Back Office Servers

Data Link

Authorities

Location Reports

Position Reference

GPS

PTC On-Board Equipment

Track Integrity

Signal Aspect

Switch Position

PTC On-Board Equipment

- Human-Machine Interface Display
- Train Management Computer (TMC)
- Location Determination System
- Digital Radio
BNSF, CSX, UP and NS have formed the Interoperable Train Control Committee to develop Interoperable-Electronic Train Management System (I-ETMS) PTC system requirements.

I-ETMS has received “Type Approval” from the FRA and is the basis ARRC’s implementation of PTC.
Considerations for Implementation
PTC - Why?

• The Alaska Railroad is a full-service passenger and freight train operation.
• Began voluntary program to implement PTC in 1997.

Daily north-bound and south-bound Denali Star Passenger meet at Broadview (dark territory) daily.
ARRC PTC

• ARRC intends to implement a **vital** end to end positive train control (PTC) system at the Alaska Railroad Corp.

• Vital PTC implementation approach has been chosen by ARRC:
  
  • to reduce the expected operational impacts of a system that does not support electronic only distribution of mandatory directives.
  
  • To support dynamic authority generation and distribution
PTC Operations

PTC is used in conjunction with a railroad’s current train operation controls, providing a safety overlay to eliminate human errors. ARRRC’s train operations include:

- **Centralized Traffic Control**
  Train movement based on signal remotely called by a dispatcher.

- **Track Warrant Control**
  Train movement based on dispatcher providing a movement authority and transmitting verbally the limits of the authority.

- **GCOR 6.28 Movement on Other Than Main Track**
Anchorage Terminal Operations

ARRC will operate with Track Warrant Control rules at the Anchorage Passenger Terminal since passenger and freight share the track.
Origin of PTC at ARRC

ARRC began voluntary implementation of PTC in 1997.

- FRA no longer allowed other track equipment to operate on “track car lineup”.
- Method of Operation changed from train orders to industry standard Track Warrant Control to accommodate a Computer-aided Dispatch (CAD) – implemented in 1999. CAD was implemented to eliminate human-factor errors due to issuing conflicting authorities.
- UP and BNSF test Positive Train Separation System to/from Oregon to Washington.
- VP Transportation wanted to eliminate human-factor error that caused a near-miss between a NB freight and a SB loaded coal train near Montana Creek on June 30, 1995.
Grandview provides challenges operationally and implementing PTC.
220 MHz Base Stations

- MCC Specifications and Network Design Principals documentation were used for Overlapping Coverage and Channel Reuse Planning
- Existing ARRC Data Radio Network currently provides coverage in the 44 MHz and 151 MHz bands
- 151 MHz radios are being removed and replaced with 220 MHz Base Station Radios
- 220 Radios are higher powered – 75 Watts versus 25 Watts for higher coverage
- 220 Coverage will again be tested during pre-FRA witnessed Critical Feature & Route Validation and Verification
Communications Reliability

North End
Terrain and Power Challenges

- One generator site and one Wind/Solar
  - Generator Site: rail access only, two generators
  - Wind/Solar Site: helicopter Access only
- 80% overlapping coverage
  - One new tower required
- Existing Microwave Repeater Sites will be back hauled with diverse routes
- Battery replacement program provides 72- hours of backup power
- Added systems management and monitoring of power systems
- 99.88% availability at worst location
Communications Reliability

South End
Terrain and Power Challenges

- Two generator sites and one Wind/Solar
  - Generator Sites: Rail access with one redundant Generator
  - Wind/Solar Site: Helicopter Access
- Engineered for 100% overlapping coverage
  - One new Base Station Required
  - One tower will be replaced
- Existing Repeater Sites will be back hauled with diverse routes
- Battery replacement program provides 72-hours of backup power
- Added systems management and monitoring of power systems
- 98.65% availability at worst location
On-Track Wayside 220 Coverage

220 MHz On-Track Drive Testing
- Two HyRails equipped with telescoping antenna masts used
- First HyRail located at manual switch locations or Control Points to simulate wayside location
- Second HyRail starting at 4-Miles out from the location, drove towards the location
- GPS used to record position every second
- Signal level received from the wayside location recorded every second
- Pings sent over the 220 MHz link at 1-second intervals to verify data connectivity
- Tests were repeated going away from the location

Legend
- >70
- 40 to 70
- 20 to 40
- 0 to 20
- <10

NSS Brookman North to MP86
RX PTC 220.4125 dB 1/18/2012 2:35:52 PM
Scale = 35,000 : 1 1 in = .55 mi
Plot Center = N 60:57:18.8 W 149:24:14.8

No observed problems

Ping statistics for 192.168.2.1:
Packets Sent = 1257, Received = 1188, Lost = 69 (7% loss)
Approximate round trip times in milli-seconds
Minimum = 170ms, Maximum = 3955ms, Average = 285ms

AlaskaRailroad.com
220 Wayside Google Earth

Coverage Results Overlaid on Google Earth

- MP Markers and Wayside locations are displayed
- Used to compare Anomalies or Poor Coverage areas to Terrain
- Potential problem areas were verified to have Base Station Coverage
PTC 220 MHz Radios

Considerations:
- Secure spectrum
- Radio availability
Wayside Segment

IP Network

COMMUNICATIONS SEGMENT

ITCM

220 MHz

WMS

IMG-2

CTC Code line

WIU CTC

Microlok

or

VHLC

ElectroLogIX

or

WIU

Dark Territory

ElectroBlox

Wayside

Monitored Signals

Monitored Switches

AlaskaRailroad.com
Dark Territory wayside location

For locations where we do not have commercial power. Solar and wind power is primary source of power.
Typical Control Point
ARRC has 54 locomotives in its fleet. Categorized into six different basic types:

- **GP38-40**
- **SD70MAC w/ CCBI** and Distributed Power
- **SD70MAC w/ CCBII**
- **SD70MAC w/ CCBII** and Distributed Power
- **F40**
- **DMU**

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<th>Unit Numbers</th>
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23 GPs
28 SD-70MACs
2 Cab Cars (P31/P32)
1 DMU=54
Surveying ARRC’s Fleet

In August 2011 Wabtec Global Services (WGS) conducted a survey of ARRC’s fleet of locomotives.

Locomotives were categorized into six types of locomotives for PTC installation.
Surveying ARRC’s Fleet

The survey produced and aided in:

• Proposing mounting locations and methods
• Defining cable lengths
• Defining locomotive interface requirements
• Evaluating potential CAS equipment re-use
• Identifying hardware mounting locations for the new event recorder, GPS and 220 MHz data radio
Installation of Equipment

I-ETMS requires each controlling locomotive unit to be equipped with a Train Management Computer (TMC), two computer display units, crash-hardened event recording, interface to locomotive brake system and radio(s).
ARCC Locomotive Communication Equipment

Complete Antenna array that will support GPS, Wifi, and 220 MHz radios.

- Wifi
- 220 MHZ Radio
- GPS
- TMC
- 220 MHz Radios
- TRIMODE ANTENNAS
- 44MHz
- 220MHz "TX/RX"
- 220MHz "RX"
Two CDU Installation
Installation of Equipment

The screen on the Conductor’s side will be an independent view only screen.

The screen on the left is a authority detail screen that the conductor can view while the screen on the right is the Main (Home) screen being viewed by the Engineer.
EMD SD70MAC Installation
Sleeping Lady Engine 557

557 is the controlling engine and PTC equipped on its way to Anchorage.
Considerations for Implementation

- Start now working on preparing track map data in the prescribed format.
- Survey of locomotive fleet to develop installation plan of I-ETMS and communications equipment.
- Negotiate sooner then later with your shared trackage RRs regarding change management.
- Stay in contact with the FRA.
- Define a training and certification plan.
- Understand communication needs early.
How PTC Works

- Before a train leaves its originating terminal on-board computer is initialized.

- GPS works in conjunction with geographic track data base to determine the train location on the track and to ensure adherence to train movement information.

- As the train moves the onboard computer constantly calculates a warning and braking curve.

- As the train moves down the track the on-board computer pings wayside devices checking for broken rails, proper switch alignment, and signal aspects.
PTC Exemptions

FRA has granted 5 exemptions to the 44 railroads required to install PTC:

- All for operations more limited than ARRC.
- All have special restrictions that impact operations.
- Largest is for 14 trains per week; ARRC has about 70.
- Amtrak passenger trains carry about 200 passengers.

49 CFR 236.1019 (c) Limited Operations Exceptions

- Trackage used for limited operations by one pas
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