

NTSB POSITIVE TRAIN CONTROL SYMPOSIUM (MARCH 2-3, 2005)

PTC (Positive Train Control) relies heavily on micro processor decision based train control systems to manage train movements, enforce speed restrictions, and territorial limits.

PTS (Positive Train Separation) does not rely on micro processor based train control systems. It is designed to enforce proximity limits between vehicles in signaled or non-signaled territory.

The final PTC rule was Monday, March 7, 2005.

1. The rule is premised on a principle that PTC operations must be at least as safe as the train control systems it will replace
2. Carrier's will be required to prepare a safety case that will convince the decision makers that this will be the case

INTEROPERABILITY The ability to interchange and operate PTC / PTS equipped locomotives between roads is not guaranteed, given existing levels of technology. Communication system differences (satellite vs. proprietary wireless) are the primary obstacles. An interoperability plan for interchanged equipment may take shape within a year. The railroad and equipment suppliers have not developed a communications plan. The transmission of Data Radio signals provides the most economical means of enforcing temporary speed restrictions considering the high cost of track imbedded transponders.

VITAL PTC SYSTEMS

The architecture of Vital PTC Systems relies on micro processor generated signals moving between wayside transponders, signal systems, GPS equipment, and software programming designed to analyze real time information and make decisions that can effectively manage train speed, enforce track limit authorities, and maintain appropriate separation distances for following movements. In my opinion, the Amtrak ACSES system and New Jersey Transit's ASES system may reduce some operator training and qualification requirements, considering the systems are designed to evaluate information and can automatically initiate some of the actions previously performed by the engineer. I understand these systems will be governed under separate PTC operating rules and in the event of malfunction; the default will be train stops.

OVERLAY SYSTEMS

A train control system that augments but does not replace the former or pre-existing operating system. Warnings and other information is provided to an operator in the form of audio/visual aids. To preserve/insure the safety of operations, the train crew must continue to comply with the operating rules governing train movements that were in effect prior to installation of an Overlay System. Overlay Systems using track maps and location information provided by GPS equipment and wayside transponders have the ability to detect and determine the exact speed and position of trains. Communication is provided by proprietary wireless or radio signals transmitted using a variety of frequencies. Standardization is lacking.

Overlay systems are not designed to be vital (fail safe). The train continues to be controlled by an operator who must be trained to make the decisions necessary to operate throttle and braking systems. If an Overlay System should fail, the operator will not continue to receive audio/visual queues and the Direct Intervention features will not function. The operator will continue to perform service governed by the Operating Rules that were in effect prior to installation of the Overlay System.

One concern, operators who become accustomed to real time information and advance warnings may become reliant on the system, rather than cognitive ability, and fail to determine the proximity of restrictions.

DIRECT INTERVENTION

Based on the sophistication of a particular system's hardware and related software programming, radio receivers coupled to a locomotive's control circuitry may, upon receipt of signals from a transmitter at a remote site, cause the brakes to apply and a train to stop before reaching a predetermined point. Depending upon the system and infrastructure, this may occur prior to the time when a train actually exceeds either the prescribed speed or limits of track and time authority.

Ron Hynes (Associate Director NTSB)

NTSB does not correlate crew size as a factor in human failure accidents

Robert VanderClute (Sr. Vice President AAR)

Train Braking – The braking characteristics of a freight train are unique to each train and “never duplicated” in actual operations.

(Each train consist is different with regard to number of cars, equipment type, weight per operative brake, car braking equipment design, locomotive consist and dynamic braking characteristics. Rail conditions, weather, grade, speed, and time also enter into the equation)

The braking algorithms incorporated into the microprocessor based programming architecture of PTC systems are based on “worst case” braking scenarios. When the system intervenes, it is designed to stop the heaviest train, with the maximum amount of permissible inoperable brakes, under the worst possible rail and weather conditions, sufficiently short of a positive stop signal, work restriction, or speed restriction, using a full service train brake application. If 1200 feet back from the signal provides the essential margin of safety, most trains will be stopping at significantly greater distances.

PTC can reduce line capacity. The cost benefit ratio is less than one (1), and the technology is not proven

Our engineers are trained to control speed and are able to pull up to a signal and stop

We have determined: That PTC will require the investment of at least 7.8 Billion Dollars and provide quantified benefits only equivalent to small portion of that amount

EXISTING PROJECTS

IDOT (Illinois Department of Transportation)

This is probably the most sophisticated freight operations train control system under development and testing. It involves implementation of "state of the art" microprocessor based Train Control Rules and software programming to make control decisions. This system incorporates on board data bases, track imbedded transponders, GPS, provides dynamic / rolling block authorities, and permits remote operation of switches from inside the locomotive cab. Currently, the system is in place and being tested in the territory between Chicago and St. Louis, I understand, on trains operated by Union Pacific and Amtrak.

ITCS Michigan Positive Train Control Project

ITCS (Integrated Train Control systems) currently being tested by Amtrak and Norfolk Southern in territory between New Buffalo and Kalamazoo, MI. NS has modified several locomotives to accommodate the ITCS system.

19.1 million received from FRA (track upgrades, ITCS equipment, grade crossing improvements)

39.1 million total investment (includes 500k for fencing – 900k for private grade crossing elimination)

NEW JERSEY TRANSIT

ASES (Advanced Speed Enforcement system). Similar and compatible with the Amtrak ACSES system. This system does not however employ the on board data bases incorporated into the Amtrak system. It utilizes and complements the existing CAB signal systems by means of track imbedded transponders communicating speed time and distance information, via radio data signals, between microprocessor based apparatus installed on the vehicles, way side equipment, and stationary servers located at a remotely situated control center, providing speed, positive stop signal, work restriction, and civil speed restriction enforcement. The system also provides for radio transmission of temporary speed restrictions. All installations require precise location data. The railroad must be surveyed to obtain accurate measurements for installation of the track imbedded transponders. The NJT and AMTRAK systems are unique, in that they are equipped to determine the actual position of grade level crossing gates including the time a gate was lowered prior to the arrival of a train. This information is used to predict and enforce appropriate train speeds at crossing locations.

AMTRAK

ACSES (Advanced Civil Speed Enforcement System) Similar to the New Jersey Transit's ASES system in design and function. Amtrak currently uses cab signals (CSS) and speed control (SCS) for train control. The ACSES system is required for high speed (125-150 mph) operations and affords the necessary Positive Stop enforcement function at interlockings and stop signals, speed restriction enforcement, and also permits radio transmitted delivery for temporary speed restrictions.

This system has been installed and is being tested, in combination, over 428 miles of track.

28.5 million has been spent for equipment

14.1 million has been spend for installations

50k is the cost to equip one (1) locomotive

47k is the cost per mile of track

CSXT

CBTM (Communications Based Train Management) This system does not conform to vital (fail safe) requirements in that the train crew must comply the Rules governing speed restrictions, stop signals, etc. in the exact manner and fashion that was required prior to implementation of CBTM. The system is intended and designed to provide assistance to the train crews by audio/visual warnings (alarm and flashing light) and positive intervention (service brake application) under the following conditions.

1. Failure to stop at end of authority (provides advance warning followed by intervention if the train proceeds beyond a predetermined location).
2. Enforce speed restrictions (provides advance warning and intervention if train exceeds the speed limitation at the location of a permanent restriction, such as a curve).
3. Switch Position (monitors selected manual switches, dependent on the installation of transmitters and other necessary equipment at the location of the switch)
4. Work Zones (prompts for authority to enter a work zone)

According to CSX, "Braking algorithms are a real challenge" In heavy descending grade operations when a 2 – 3 mph over speed causes a penalty brake operation on a loaded coal train, we have to tie down forty (40) cars in order to recharge the train. CSX also believes the programming requirement mandating that trains stop prior to reaching a point 1200 feet in advance of the "limits of the train's authority" are excessive.

CBTM is based on two requirements. First, that a train dispatcher communicates a restriction to the train crew and second, that the crew respond. This information is thereafter entered into a software program and the server communicates with the vehicle (locomotive), generating a warning prompting the crew upon approach and, subsequently if necessary, by stopping the movement in the event that speed or territorial limitations are actually violated. This system is intended and designed for use in what is currently dark territory. I understand that CBTM is being tested on 30+ miles of track in the vicinity of Spartanburg.

CSX management indicates that many issues remain unresolved, most significantly the inability to guarantee INTEROPERABILITY of equipment between interlining carriers.

ALASKA RAILROAD

CAS (Collision Avoidance System)

This is probably a PTS (positive train separation) system. Transponders installed on trains and on track equipment communicate the distance between vehicles and cause intervention (full service brake pipe application) in circumstances when the distance between vehicles does not exceed predetermined distances.

BNSF

ETMS (Electronic Train Management Systems) This system currently provides highrail proximity warnings and enforces track authority limits via vehicle mounted transponders using GPS to determine locations. Carrier has equipped 1700 of 2800 high rail vehicles to date.

The ETMS system provides a "safety net" for train operators utilizing existing rules for train control including, but not limited to, rules governing switch position, track authority, speed restrictions, etc. The system has the ability to determine track integrity provided the track is bonded. It has the ability to provide advance signal aspect and main line switch position information dependant on installation of the necessary transponders, transmitters, and detection equipment. It also has the capability to enforce track authorities and work limits by communications between transponders on a locomotive and portable signaling equipment operated by maintenance of way employees situated at a work site.

ETMS provides direct intervention (by means of a full service brake pipe application) if a train approaches a positive stop signal, limits of track authority or, a speed restriction at velocities inconsistent with data base information indicating that the train is under control. This system also provides direct intervention if a train passes a positive signal or exceeds proximity limitations with respect to the location of other on track machinery.

A cab mounted screen provides the operator with a real time graphic display that incorporates a moving horizontal band inserted over a track profile indicating the distance between the locomotive and a restriction, train moving ahead, work order, etc. A warning is provided indicating that intervention will occur in 60 seconds, 40 seconds, etc. should the speed not be reduced consistent data base information and braking algorithms. The method of intervention involves a full service brake pipe application and activation of PC or generator field switches to eliminate power.

In order to resume operations, following intervention an electronic signal must be transmitted from a control center to unlock and reset circuitry on the locomotive.

BNSF currently has fifty (50) ETMS equipped locomotives assigned to the Beardstown subdivision and thirty eight (38) engineers trained to use the equipment. To day, ETMS technology testing involves one-half of the trains operating in the territory. The process is in the final testing stages and BNSF "is working to bring the system into a pilot state".

BNSF further expressed concerns regarding interoperability of the various systems on foreign line trackage. Interoperability (the ability to interchange and operate PTC / PTS equipped locomotives between roads is not guaranteed, given existing levels of technology). Communication system differences (satellite vs. proprietary wireless) are the primary issue. An interoperability plan for interchanged equipment may take shape within a year. The railroad and equipment suppliers have not developed a communications plan. The transmission of Data Radio signals provides the most economical means of enforcing temporary speed restrictions considering the high cost of track imbedded transponders.

BNSF (David Dealy) stated that they are committed to moving forward based on a determination and belief that it would be wise to make the necessary expenditures for PTC and commence operations as soon as possible.

UNION PACIFIC

Stated that its engineers are trained to pull up to a block signal and stop. The Predictive Braking component of PTC systems, using worst case braking scenarios, will stop most trains over 1200 feet from a stop signal and reduce train velocity. A 1 mph reduction in train velocity equates to a 75m annual revenue loss. The UP system is saturated because, in many cases, more cars enter the system in comparison with the number that depart each day. From a productivity aspect, PTC may reduce velocity and UP can not deal with the consequence. There are no proven systems to analyze. The concept has some promise, however it will be a long time until the systems are revenue ready. Forty percent (40%) of our business is interline. We might coalesce to a proven INTEROPERABLE system, but do not believe there will be interoperability of equipment between railroads for at least two (2) years.

NORFOLK SOUTHERN

Stated that NS has supported the PTC effort. NS is interested in the potential for PTC and will consider investment when the systems are tested and proven to be revenue ready. NS does not believe this to be the case today.

ECONOMIC CONSIDERATIONS

The original paper based systems using train orders and track warrants have changed very little with the exception of communication methods. Blocks signals were installed beginning in 1893 and CTC in 1923. Equipment wears out and replacement parts are difficult to obtain.

The cost of converting existing signaled track to PTC is estimated to be between 2.3 and 4.4 billion.

Class 1 Carrier's are investing 564m annually to replace communication and signal equipment today.

It costs 140k / mile to install CTC equipment and 65k /mile to convert signaled track to CTC. One-half of tracks are currently non signaled territory. The cost to signal the Class 1 systems amounts to around 9 billion.

PTC Costs:

35k – 75k per vehicle

16k – 24k per mile of track

100k – 500k per office/control center

An expenditure of only 2.3 to 4.4 billion will convert existing signal systems and equip dark territory for PTC operations. This contemplates replacing existing signal systems and covering 100% of Class 1 territory. Perceived benefits include controlling the human factor element, improvements in velocity, and fuel savings derived from pacing trains.

When compared with the known costs associated with standard CTC signal systems, PTC based train control systems, in theory, are projected to be less expensive to install and maintain. The difference amounts to between 4.6 and 6.7 billion in savings.

GPS COVERAGE

In commercial application, the evolution and use of Global Positioning Satellites (GPS) focused on maritime industries and their requirements for accurate location information. As a consequence, GPS coverage is currently adequate only in ocean costal areas and the vicinity of the great lakes. Full coverage will not be obtainable within the interior until the Coast Guard converts decommissioned Air Force ground wave radio installations to process GPS signaling information. At present, this project has little government priority and it will be many years before the type and quality of GPS coverage necessary to accommodate Positive Train Control systems will be available throughout the country.

In order to accurately determine the location of an object, there must be a line-of-sight reference between at least two (2) satellites and the object at all times. When an object is positioned within a city with tall structures (urban canyons), river valleys, or other locations where information from two (2) or more satellites is not available, GPS systems can not perform the calculations necessary to determine or fix a location. Positive Train Control systems relying on GPS communication will fail in this environment except when track side transponders are installed to provide a second source of information for computer analysis.

PCT AND HUMAN FACTOR (performance) CONSIDERATIONS

PTC deals with the symptoms and not the underlying cause of human factor errors such as fatigue, training, physical plant, etc.