TPWS- Train protection and Warning System

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The publication in the Spring of last year of Sir David Davies recommendation to adopt the Train Protection and Warning Systems (TPWS), followed on from decisions already taken in 1999. In the initial estimates, a cost of £100 million was expected to cover the installations, borne by Railtrack. By the time Sir David Davies report appeared, Railtrack's own network Management Statement gave the cost of £310 million, applied to 40% of lineside signals in a 3-year implementation. The principal objective of TPWS is to reduce the number of SPADs and in consequence, the reduction of accidents and fatalities attributed to this cause. It is not ATP, but a tactical step along the way that can easily be incorporated into existing systems, whilst still following the Europe wide standards for train control and signalling systems.

Fig:1 Relay Room in a conventional Signalbox. This technology is being rapidly superseded by solid state, electronic equipment, whilst the lineside equipment is being enhanced with TPWS and ATP systems.

Given the decision to adopt a "halfway house" to expedite an improvement to signalling and train control for Railtrack and ATOC members, the choice of a Train Protection and Warning System (TPWS) may be seen as controversial. However, that some changes in rail safety need to be brought into use in short order is undoubted.

Currently, AEA Technologies are the prime contractor for the supply of TPWS. Alstom Signalling (formerly GEC Alsthom Signalling) were to supply the TCS system for the West Coast Upgrade programme. TCS as proposed was fully ETCS compliant to Level 1 and Level 2, but Britain's rail network needed a simple and effective solution at lower cost and in a shorter timescale. The TPWS system builds on the existing AWS and DRA (Driver's Reminder Appliance). It is fully a year since the proposal to use the alternative, as recommended by the Royal Society of Engineers was publicised, since when, significant progress has been made towards its installation.

Taking the need to reduce the number of SPADs and tragedy of the Ladbroke Grove accident in October 1999 as the primary drivers, TPWS was seen as the quickest and most likely first step towards full ATP, using the ETCS model. Deputy Prime Minister, John Prescott called for a review of options for improvements to rail safety following this disaster, resulting in the current implementation of TPWS.

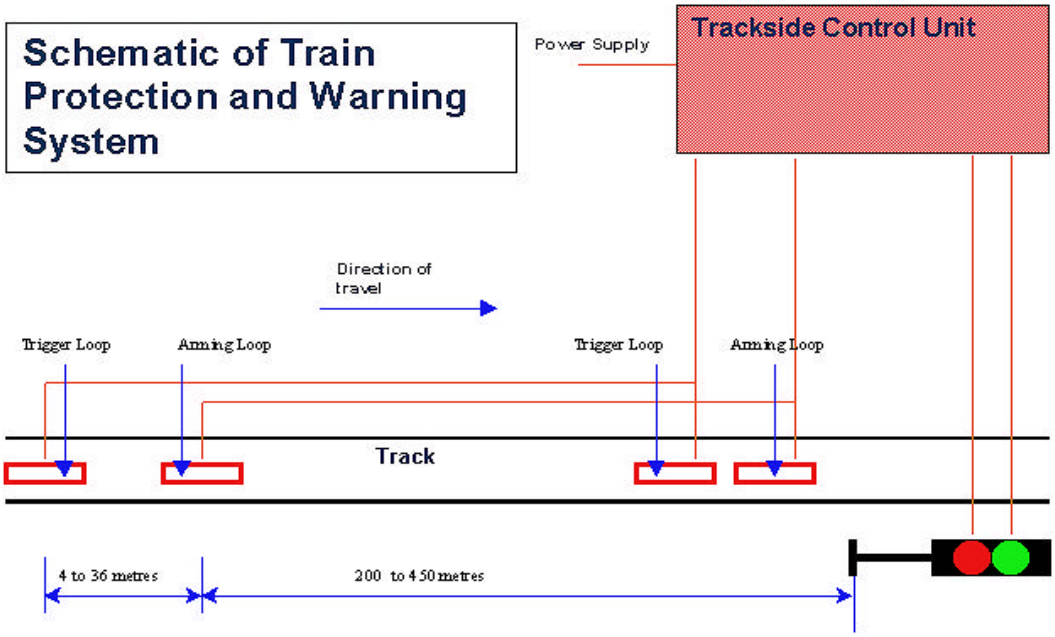

Fig: 2 Schematic of the principle elements of TPWS technology, protecting stop signals now being introduced at more than 1,000 locations on the rail network

What is TPWS?

TPWS incorporates the existing AWS, but provides a higher degree of train protection. It is yet to be widely fitted on the mainline network and implementation details to optimise effectiveness are being drawn up by industry with a view to full implementation by the end of 2002, early 2003.

There are in fact two versions of TPWS – a basic installation that caters for train speeds of up to 100 km/hr (75 mph), and a second version (TPWS+) that can cater for speeds of 135 km/hr (100 mph). On top of this, there is a further development, looking at the interaction of TPWS with the Eurobalise functions of ETCS,

as TPWS-E. ETCS forms the core of the European Train Management System (ERTMS). In the USA too, developments in sophisticated train control systems are being investigated, though unlike the European version, as yet there is no evidence to support its suitability for a European application. The US experiment is similar to the European ETCS, corresponding to Level 3, with signalling based on communications links, without trackside installations.

TPWS Operation

Two pairs of loops, placed between the running rails acting as transmission beacons can initiate emergency braking to halt the train if it is either about to pass a red signal (the 'train stop' facility) or has exceeded a maximum permitted speed by more than a set margin (the 'speed trap' facility).

Speed traps can be fitted at the approach to signals in order to slow down a train travelling at above the permitted speed sufficiently to avoid most of the more serious SPADs, where the train overshoots the signal by such a large distance as to cause an actual danger such as a collision or a derailment. They can also be fitted at any other location where a speed restriction is required, for example at the approach to buffer stops, sharp curves, or track under maintenance.

Unlike AWS, the driver will not be able to override the system. TPWS has been designed to be simple to fit to existing track and trains.

How Effective is TPWS

According to the HSE, TPWS should reduce the risk of collisions or derailments, compared with traditional AWS and DRA alone. TPWS, unlike ATP systems does not monitor the train continuously. An interesting concern raised in some quarters is the possibility that TPWS may not be totally effective if the driver of a train disregards caution signals and approaches a red signal at high speed.

It will however provide greater protection than AWS – which can simply be overridden, or by the DRA, which is only effective when trains are stationary as means of ensuring the driver confirms the signal status before setting off.

Implementation Progress

TPWS is being implemented at conventional stop signals. By August 2000, 1,200 such signals were identified by the industry working group, established for that purpose. Of these, 400 have had the equipment installed and 40 fully commissioned.

In the spring of last year, Railtrack had committed to the implementation of TPWS across the network, aiming for completion by 2001. In Railtrack's 2000 Network Management

Statement, the following locations were planned to see installation in 2000/2001:

Great Eastern (Norwich – Sheringham), as part of the resignalling of this route in 2000/2001
Midland Main Line – all routes, following the completion of the pilot scheme at the southern end of the route, into London, St Pancras.

First Pilot spends on TPWS in 1999/2000 (£200,000) and in 2000/2001 (£200,000). The implementation programme was accelerated in 2000, following publication of Sir David Davies report.

Whilst progress with TPWS implementation is good, in the long term, there may be issues for both Railtrack and the train operators that could prove costly. The reason for this, is that both the lineside and train-borne equipment cannot easily be upgraded to ETCS compliance, and to provide full ATP, leading to further work. This was recognized in the 2000 report, and it has been recommended that provision for ETCS be included in all new designs of rolling stock.
In addition, recognizing that there will be difficulties associated with inter-operation and integration of TPWS systems with the ETCS systems, a further pilot trial of TPWS (TPWS-E) is to be undertaken, using components from the ETCS system.

ETCS – ATP

The implementation of full Automatic Train Protection is achieved under the European standard, ETCS. This is in fact adopted as a the European Standard, under Directive EC 96/48, for application to all designated high speed routes. ETCS was, and is planned for installation on Railtrack's main high-speed routes, and the West Coast Main Line will be the first route. Here, with Alstom's TCS technology, equipment conforming to ETCS Level 1 and 2 is to be installed. Two other routes – the East Coast Main Line and the Midland main Line – were identified by Sir David Davies' report as being suitable candidates for ETCS and full ATP. The ECML, according to the February 2000 report should be upgraded from 2006, whilst the Midland Main Line is not a key European high-speed route, would be a suitable route within the UK.

The UK has and is participating in ETCS trials already, as part of the process to decide whether to use beacons or loops as transponders, between the running rails. On Chiltern and great Western lines, ATP based on the use of the ETCS "Eurobalise" magnetic transponder is in operation today. The "Eurobalise" is an inductive device that does not depend on an external energy source, unlike the TPWS loops.
The ETCS technology chosen is a magnetic transponder, uses inductive coupling to transmit energy from the train to the balise, and information in both directions. Implementation of ETCS based ATP can be phased, allowing adaptation of existing systems and rolling stock. The system provides the following levels of operation:

Level 1 - to provide ad-hoc/spot transmission of information between track and train, over and above the existing signalling systems. Train detection is based on fixed lineside equipment, and train spacing is fixed block. Radio communication is not essential at this level of application, since optical signals are still in place.

Level 2 - at this level, data transmission to the on-board displays allow the replacement of optical signals, but train headways are still maintained through the fixed block system, and train detection still depends on fixed, lineside devices. Some information, like train driving authority is provided by radio communication.

Level 3 - the final level removes the need for train detection by lineside devices, and utilises a "radio block centre". Maintenance of train headways can be achieved at this level based on their braking distance, and adopting a moving block system. At this level, Euroradio becomes a vital component in ensuring continuous information transfer between the trains, and associated train management systems.

The various rail networks in Europe are adopting ETCS based ATP systems on their high-speed routes already – the French TVM systems is actually in use today in the UK, on Eurotunnel, whilst LZB, a Siemens product is used in Germany. Having ratified the basic technology, inter-operation throughout Europe remains the next objective.
However, we will look at the development and application of ETCS based ATP systems in more detail in later issues.

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