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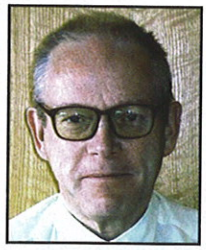
Lineside Speed Signage: the Past and the Future

Test Site A Speed Sign (WCML Carnforth-Carlisle). Photo © Mott MacDonald/Network Rail 2004.



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INTRODUCTION

Lineside speed signage is a discipline that can affect any permanent way or signalling design. As an introduction to lineside speed signage, this paper aims to illustrate the history of speed signage and to highlight the current and future design aspirations.

Overlooking the design of lineside speed signage can, in worst cases, severely limit the speed or capacity benefits desired from a given project, if left unaddressed until the end.

Through the West Coast Route Modernisation (WCRM) Project, Network Rail and Mott MacDonald have been successfully involved in providing lineside speed signage designs for the West Coast Main Line. This project has, along with others, facilitated the introduction of Enhanced Permissible Speed (EPS) onto the WCML, allowing tilting trains to travel at speeds up to 125mph[1].

Mott MacDonald's speed signage design work has led to the development and implementation of a Network Rail design procedure for use on WCML. The signage project is closely linked to the WCML Tilt Authorisation and Speed Supervision (TASS) System, which ensures tilting trains are supervised to the correct Enhanced Permissible Speed (EPS) or Permissible Speed (PS). The lineside speed sign locations, designed by Mott MacDonald, are a direct input to the design of the TASS system.

This paper does not intend to draw any conclusions regarding the design of route signage, but rather to provide a starting point for a subject more complicated than initially anticipated, describe the positive work that has been implemented as part of the WCML upgrade works and the features a signage scheme should portray.

A BRIEF HISTORY OF LINESIDE SPEED SIGNAGE

Pre-1945

Early railways were very slow, limited to walking pace because of the fear of what would happen to passengers' health if they were transported too fast. In those days the speed limit was enforced by a man holding a red flag, preceding the train on foot or horseback.

As speeds increased, the flag-man was dispensed with and the responsibility to limit the train speed passed to the driver. However, speed indicators did not exist; drivers were not issued with watches and locomotives were not fitted with speedometers, despite there being speed restrictions in existence.

Examples of imposed speed restrictions are documented in the London and North Western Railway Company Rule Book of January 1849, and the London Midland and Scottish Railway Company (Western "A" Division) *Special Instructions to Drivers – Limitations of Speed of Trains at Certain Places,* dated July 1925. The latter document makes reference to the existence of a speed indicator "fixed on the down side of the line, 533 yards south of Eamont Junction Signal Box, to indicate to drivers where speed must be reduced. This indicator will be illuminated at night."[2] It may be that this was the only speed indicator on the LM &SR Western "A" Division.

It is therefore reasonable to ask how drivers observed speed restrictions, given there were no watches or in-cab speedometers.

The answer is that drivers used various methods to calculate their speed, for example counting rail joints or quarter mileposts, but most speed restrictions were simply judged by experience. It is only within the last 60 years or so that lineside speed signage has become an integral part of the rail infrastructure.

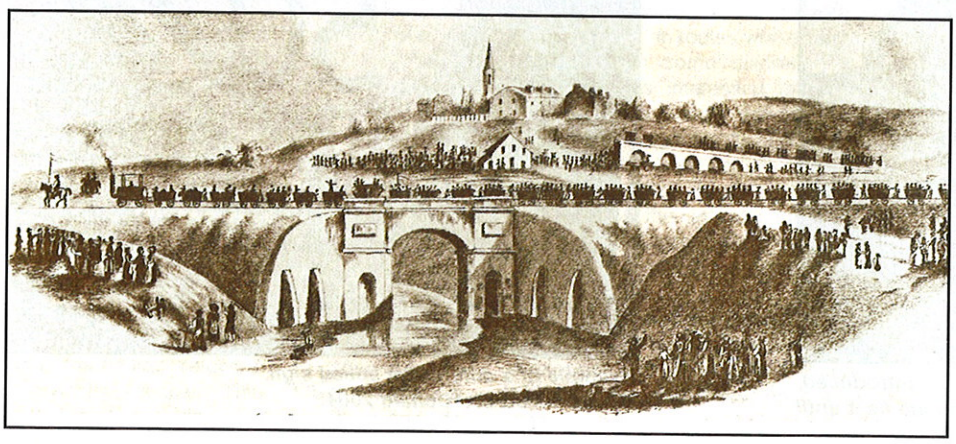
Introduction of Yellow "Cut-Outs" 1945-1960

According to L.T.C. Rolt, in his book *Red for Danger* (p286)[3], The London and North Eastern Railway for many years marked its principal speed restrictions by white painted figures "cut-out" of metal, denoting the speed concerned. These were later adopted, with a change in colour to yellow for greater ease of observation, as standard throughout the British Railways. Studies of old railway photographs do not show much evidence of general use of "cut-outs" until the late 1950s.

During this period, speed signs were only provided for the commencement of speed restrictions. The maximum PS of a particular section of line was not signed, nor were standard speed restrictions; for example, a speed restriction of 15mph through crossovers between parallel tracks. Up to this date, the fastest authorised speed was 90mph.

Development of yellow "Cut-Outs" during the early 1960s

Regular high speed running came in the early 1960s, with the introduction of the Deltic diesel



Two views of a man on horseback preceding a train on the Stockton-Darlington Railway. He would be carrying a red warning flag and sometimes walked instead of riding a horse. Drawings © The Mansell Collection.

locomotives on the East Coast Main Line (ECML), which were the first traction units with a designed maximum speed of 100mph, although other trains had exceeded this speed on certain special occasions in the past.

During the 1960s the maximum speed on the ECML route was raised to 100mph. For performance and publicity reasons, it was deemed appropriate for signs to be provided to indicate the maximum permitted speed of a route where the speed was 90mph or above; thus a form of continuous route signage was born.

"Morpeth" Boards Introduced in 1969

The increase in line speed brought with it an increase in risk of trains traversing a section of track at a speed greater than the speed for which it was designed.

Following an overturning incident at Morpeth curve in May 1969, Her Majesty's Railway Inspectorate required that drivers be given advance warning of severe speed restrictions, via a Warning Indicator.

The Mark I version of these Warning Indicators comprised small black circular signs with a yellow border and white numerals, externally illuminated and provided with a permanent Automatic Warning System (AWS) magnet. These Advance Warning Indicators, now commonly known as Morpeth Boards, were introduced on high speed lines. However, following another similar incident, the criteria were refined and are now detailed in *GK/RT0038[4], Signage of Permissible Speeds and Speed Restrictions.*[4]

Introduction of Standard Differential Speed Signage

Differential speeds of various forms have existed for many years, notably on sections of line predominantly used by passenger trains with shorter braking distances between signals. In these situations a lower speed was imposed on freight trains, hence the introduction of the differential speeds. Differential speeds were usually only published in the Sectional Appendix[5], as a maximum permitted linespeed and no lineside signage was provided. In one particular case, between Stockport and Buxton, a triple differential existed, applying to passenger trains, light locomotives, and freight trains. Remnants of this and other examples still exist in the North West Sectional Appendix, still without lineside signage and not particularly relevant to today's operation of the railway. In some instances, however, lineside signage was provided by yellow "cut-outs" in the form of one speed above the other, with an explanation in the Sectional Appendix as to which speed applied to which type of train. Some of these still exist even though they do not fit the current Rule Book[6] definition of a standard passenger/freight differential.

Example of a cut-out speed sign. ***Photo© Mott MacDonald 2004.***

Standard passenger/freight differential speeds, as defined in the Rule Book, became more prevalent in the 1960s with the demise of steam and a general increase in freight train speeds with more modern traction. This coincided with an era of a large number of freight train derailments, where speed was at least a contributing factor.

Something to be considered in the future is the introduction of 90mph freight vehicles and "multiple unit" freight trains. Whilst these may well have "passenger" brake timings, which in theory, would allow them to travel at "passenger" speeds, there are other reasons why it may be necessary to restrict them to freight speeds. This may well complicate the issue to such an extent that the standard differential speed as we know it may have to change or be withdrawn altogether in the interest of simplicity.

Reflectorised Speed Signs and Non-Standard Differential Speed Signage

The introduction of the reflectorised speed sign occurred simultaneously in the 1980s with the appearance of modern traction units with superior braking capability; initially Class 253/254 High Speed Trains (HST), then subsequently various types of electric and diesel multiple units. A number of sign variations were introduced, but these were eventually standardised into the types currently shown in Module SP[6] of the Rule Book.

Non-standard differential speed signage was first introduced in 1982, for Class 253/254 HSTs, and the requirements were further refined in 1985.

If differential intermediate Permanent Speed Restrictions (PSR) were required for HSTs then special signage was required, otherwise if there were no differential speeds then no other special signage was required. HST differentials were originally in the form of a special rectangular sign of yellow reflective material, similar to the current design of the Temporary Speed Restriction (TSR) board. The actual criteria for these signs was quite different to those of today. Sometimes the HST sign stood alone, and in other circumstances it was possible to fix one of the special signs to a yellow "cut-out". In these circumstances the

In 1961 the 3300hp Deltic fleet began to be introduced, becoming the backbone of the East Coast Main Line fleet until the arrival of the HST sets in 1977.

Example of a differential speed sign.
Photo © Mott MacDonald 2004.

HST differential. Photo © Mott MacDonald 2004.

"cut-out" sign had to be painted with yellow reflective paint.

Sections where HST differentials had to be applied required continuous "cut-out" signing over the whole line. Details of the HST speeds had to be included in Table A of the Sectional Appendix. The use of a special separate Table A for HSTs was to be avoided. This was a practice used on certain regions and it is interesting to note that it is still prevalent in the Scotland Zone Sectional Appendix, which is now compliant with GO/RT3206[7] Format and Content of the Sectional Appendix - Appendix A, where the presentation of speeds for different classes of train might be confusing.

In February 1988 the British Railway Board Director of Operations issued a memorandum[8] setting out the criteria for the signing of PSRs, which is effectively Continuous Route Signage. Much of this is now the subject of GK/RT0038, although a number of items which were mandatory in 1988 have since become optional extras. This seems to have led to some confusion as to what the term "Continuous Route Signage" actually means, which has resulted in the term being officially dropped in the latest issue of the standard.

It was clearly the intention in 1988 that there would be progressive change from yellow "cut-outs" to reflectorised signs. In the early 1990s Continuous Route Signage with reflectorised signage was considered by some parts of the railway industry as a means of simplifying the driver's task of route learning and therefore reducing the cost of driver training. This happened in the South East of England and a rolling programme was started elsewhere. Unfortunately the major British Rail re-organisation of 1992 put a stop to this programme. However, GK/RT0038 currently requires that any new signage be of the reflectorised type and that all yellow "cut-outs" throughout the rail network should have been removed by December 2003[4]

This has not occurred and a non-compliance deviation from the standard (certificate 04/199/NC), covering all Network Rail controlled infrastructure has been obtained to address this matter. It is understood that the continued use of "cut-out" signs does not result in an increase of risk since they have been used for over 50 years and are an integral part of driver route training.

With the introduction of Class 158 Diesel Multiple Units (DMU) with enhanced braking characteristics, in 1989, the whole subject of differential speed signage was debated again, with particular reference to speeding up "provincial" services. This led to the issue of a memorandum setting out new criteria and the introduction of the specific signs currently shown in the Rule Book. In order to achieve the objective of "exploiting the superior ride and performance"[9] of the new trains, it was specified that the arrangements must be:[10]

1. **Simple** so that drivers can clearly understand what is required
2. **Flexible** so that business requirements are met; and
3. **Standard** so that identical circumstances are dealt with in the same manner on all lines.

The criteria established previously for HSTs had to be used and this included the provision of Continuous Route Signage, but now in reflectorised form and using the various types of non-standard speed indicators authorised in the Rule Book. However, it was further stipulated that the different types of sign "must not be intermixed within a route nor, as far as is practicable, within routes worked from the same depot (though some discretion is required here.)".[10] It is interesting to record that, in allowing triple value speed signage, the standards now specifically permit the displaying of more than one non-standard differential speed value at a location. This has been exploited for the introduction of the Class 220/221 and Class 390 fleets on the Cross-Country and West Coast routes.

The Advanced Passenger Train Prototype. Photo by John Ashley © R G Latham Collection.

TSR sign. ***Photo © Network Rail 2004.***

Advanced Passenger Train (APT)

At around the same time as the HST was developed, the Advanced Passenger Train (APT) was also being developed as a research project, initially as a gas-turbine but latterly as a small fleet of prototype tilting electric multiple units specifically for use on the WCML. These were the world's first tilting trains and instigated a variant of the non-standard differential speed policy.

This work was undertaken before the advent of reflectorised signs and it was recognised at an early stage of the programme that differential speed signage would not be effective. Consequently the APT was provided with an in-cab speed display system, transmitted to the train by transponders placed at appropriate locations along the route. These transponders gave a target speed for the driver to aim at, and if the train was diverted off its designated route a warning was given in the display. If the system failed for any reason, the driver was instructed to reduce speed to that shown in the Sectional Appendix and lineside speed signage.

This was a simple and robust system, bearing in mind that at the time the prime purpose of the Sectional Appendix Table A was to provide information for the train crew. It was not then used as a source of information for people required to be on the track, although this was catered for by the issue of warning leaflets ("Watch Out – There's an APT about!") on both Scottish and London Midland Regions. These leaflets highlighted the sections of line where high speed running was authorised and staff were instructed to take appropriate actions for personal safety.

Other Forms of Advising Drivers of Speed Restrictions

Over the years there have been other ways of imposing speed restrictions without resorting to lineside speed signage. In former British Rail

The Mark II version of the Morpeth Board, introduced after the second Morpeth derailment, has improved visibility.

Regional days a number of speed restrictions were imposed on various classes of locomotive, particularly due to bridge restrictions. These were initially published in the Locomotive Route Availability booklet, but since 1992 have been included in Table A of the Sectional Appendix. Other similar restrictions on heavy axle weight freight vehicles are published in the Route Availability sections of the Sectional Appendix. In early 2002, the London North Eastern Zone published restrictions applicable only to Class 373/2 Eurostar trains on the ECML in Table A of their Sectional Appendix.

Developments with Test Site A (Carnforth to Carlisle) WCML

The work undertaken with Test Site A incorporated these principles by including the optional extras permitted by GK/RT0038 (miniature repeater signs, additional Warning Indicators, etc). The project was specifically to develop a test site, not only for the testing of the new trains but also for the testing of new lineside speed signage principles. The Class 390 Pendolino trains were run at EPS without the benefit of TASS, therefore additional Warning Indicators were provided at all reductions of speed required by the test trains, which provided enhanced test site safety.

Test Site A resulted in the development of a set of design principles which have been refined and updated as part of the West Coast project. Considerations such as the four seconds sighting of signs, composition of sighting committees, positioning of signs in the vicinity of signals and assessment of drivability have all been incorporated into the design guidance developed for WCRM.

The Purpose of Lineside Speed Signage and Publication in the Sectional Appendix

When considering high capital cost projects, such as the WCRM, it is important that all industry disciplines understand the purpose of lineside speed signage, the presentation of speed information in Table A of the Sectional Appendix and the implications these can have on their particular project.

Module SP6 of the Rule Book is quite clear that lineside speed signs and Warning Indicators are provided to "assist you (the driver) in observing permissible speeds, but do not relieve you (the driver) of your responsibility for observing all permissible speeds or Enhanced Permissible Speed."

How and where then does a driver get the information he needs to carry out his daily task of driving trains?

The answer is this. Since Table A of the Sectional Appendix is the source document, if the observance of speed limits is crucial to the operation of the railway it is vital that Table A always contains accurate and up to date information. The next obvious question then is "where does the author of the Sectional Appendix get the information from in the first place?"

Originally the purpose of Table A used to be to state maximum PS's, speed restrictions, and to authorise speeds applied to different types of traction. To this end, the document was specifically aimed at train crew; however, now it is also required by anyone who needs to go trackside. This causes a dilemma. Should it be used to authorise individual speeds for different traction types for the benefit of drivers or should it simply state the maximum PS for all trains for the benefit of others?

The more we try to extract the optimum performance out of each traction type the worse the problem becomes, as the signage has to follow the information in the Sectional Appendix. Thus, if the book is complicated, the signage will be complicated.

Currently the Sectional Appendix shows every PS in precise detail; however there are a number of cases where there is no signage on the ground. This is due to a number of standard speed restrictions, which in the past did not appear in specific detail in the Sectional Appendix and for which no signage was provided, notably speed restrictions through junctions.

If signage is to act only as a reminder, yet has to be located precisely at specific locations, depending upon the track maintenance category or sign visibility, then Table A must also be to the same level of detail, as this is the information on which the design of the railway is based.

As mentioned previously, the Rule Book states that lineside speed signage is presented as an aid to drivers. There are many reasons to both agree and disagree with this statement. Even within the driving fraternity there are those that who would say that speed signage is more than just a reminder. At the other end of the scale there are engineers who will argue that the sign is a marker in the ground where a different level of maintenance is applied, for example at the start of a transition onto a curve. Somewhere in between these two views is the optimum signage design.

Determining the purpose of speed signage will ultimately affect the final design criteria adopted nationwide.

The philosophy adopted by the WCML policy is that the signage is there to display the speeds as published in the Sectional Appendix and to provide warnings of significant reductions in speed.

WCML Lineside Speed Signage

The development of the speed signage design procedure that has been implemented on the WCRM Project has ensured the following features have been delivered:

1. Clarity – the signage scheme must be clear and unambiguous to the end user with the selection of suitable sign locations and sequences of signs that provide clear non-contradictory information. Too much speed signage information at a single location or too many signs within a short length of track can lead to driver confusion / overload.

2. Consistency – consistent application of signage design principles and policy has been delivered to minimise driver confusion.

3. Compliance – compliance with relevant Group and Company standards has been achieved with derogations or non-compliances obtained where appropriate.

4. Control – to achieve consistency, designer "interpretation" of standards has been minimised by the production of a design procedure document which specifies optimum arrangements and policies to be adopted.

5. Communication – changes to the lineside speed signage have been communicated to the end user well in advance of the changes being implemented to ensure adequate time is provided for driver briefing and familiarisation.

6. Consideration – has been given to other related rail disciplines well in advance of any proposed changes to the lineside speed signage, including signalling, permanent way and TASS - lineside speed signage can not be considered an independent discipline with no significant interfaces. Significant consideration has been given to the location of signs to ensure drivers do not become distracted from reading signals by the presence of a lineside speed sign. Consideration has also be given to the end users and their feedback and opinions have be taken into account from feasibility stage though to maintenance. Consideration has also be given to the history of signage and what drivers are accustomed to seeing, a balance being struck between change (to ensure consistency with policy and standards) and the maintenance of the status quo.

7. Cleaning and Maintenance – these activities have been considered throughout the design process to ensure the resulting signage scheme remains visible to the end user and complete. Signs are often subject to vandalism and occasional theft. Signs also need to be kept clean, as build-up of railway grime can result in the sign being unreadable.

Summary

Lineside speed signage has a direct impact on the operation and performance of the rail network and must be considered in parallel with all other rail disciplines. Having reviewed the history of speed signage, it is evident that signage design policy has traditionally been reactive to events; the launch of new rolling stock, the introduction of higher line speeds or the occurrence of accidents and incidents. Signage has also been considered to be a minor element of railway infrastructure.

Lineside speed signage requires consideration at all stages of a new rail project. As a result of Network Rail and Mott MacDonald's input to the speed signage design implemented on the WCRM Project, a consistent set of signage design principles has been developed, and could be introduced throughout the rail network in the form of a group or company standard specific to speed signage.

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