THE RAILWAY PERFORMANCE SOCIETY
TRAIN TIMING GUIDE – Volume One

1.0 INTRODUCTION

What is train timing or train recording? It is the means of recording factual data relating to a train journey, which shows times, speeds, acceleration and driving techniques and which can be compared with expectations or historical records.

Why is it done? There are many reasons, but most recorders are driven by a fascination of assessing the performance of steel upon steel, and man and machine against the elements. This was especially so in the days of steam, where a steam locomotive had its own characteristics, and every run was shaped by the character and determination of the men on the footplate. In these days of diesel and electric traction, the human element has an important, if less significant part, to play in the overall attainment. This is due to modern technology, which tends to result in less variable performance. However, there is something peculiarly satisfying about a 400 ton mass rounding curves and climbing steep gradients at three digit speeds, where ability to deploy 5000 plus hp depends on the integrity of eight contact points between wheel and rail, each the size of a small coin.

What does the recorder achieve? Some have a fascination with speed; others are interested in the power developed by the traction. Others take an overview of the complete journey: how did the train perform against the schedule, how was time gained or lost, how does this performance compare with others on the same route with the same or other types of traction, or different routes with the same type of traction. The output from the exercise is traditionally a log (more of which later) but can just as easily be a graph, histogram etc.etc.

In short, train recording is about making a historical record of the development of, perhaps, the most important aspect of rail travel - how quickly or punctually do trains make their journeys. It is for this reason that all journeys - however good or bad - can be interesting.

Traction recording is a long-established past-time and is still as relevant today with modern traction as it was a hundred years ago.

1.1 The purpose of this guide

The purpose this guide is to provide guidelines on good recording practice, with advice that may help the recorder. It is assumed that the recorder wants to make a detailed assessment of motive power performance, rather than simply monitor punctuality, which is outside the scope of this booklet.

The Society is proactive in fostering good recording practice and recognises that techniques evolve over time as individuals improve their techniques, and new technology creates opportunities for different methods which can improve accuracy and simplify the collection of data. Consequently, methods are included in this, the third edition of the Guide, which could not have been envisaged when the first edition was published. The Society would welcome comments and suggestions that could be included in later editions of this guide. Comments should be made to the Technical Officer.

The guide will explain conventional recording techniques in terms of principles of timing, obtaining distance, gradient and traction data, equipment required, preparation for the journey, the journey itself, and the tasks relating to the log preparation. Recent technology changes (including GPS) are dealt with later.

The booklet is primarily aimed at the UK enthusiast, but it is still generally relevant to overseas timing. Specific foreign advice may be added at a later date.

2 OBTAINING DATA

2.1 Route data

To be able to produce a log from a train journey, it is necessary to familiarise yourself with the route to be travelled, in respect of timing points. This is best achieved from the sources listed later. It will be noted that all locations are referenced to distance data, based on line-side distance posts. It can be seen that train timing is extremely dependent upon these line-side posts, whether in terms of calculating average speeds on the non stop 100 mile run or between two adjacent quarter mile posts. In both cases the average speed is calculated:

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}$$

2.11 Sources of Distance Information

- Official Network Rail publications, such as Sectional Appendices. These can be interesting, but they are not always accurate. The data may be out of date and the point may be imprecise and unclear.
- RPS UK/European Distance Charts. The RPS continues to produce new charts and update existing charts detailing distances at specific points at all significant locations on most UK and French main lines.
- Other commercially produced publications where RPS data is unavailable.
- Creating your own data by observation - by interpolating from times taken at lineside distance posts.
- By measuring distances from Ordnance Survey maps.

2.12 Distance posts

Britain's railways were originally required by statute to mark all their lines out with posts at quarter mile intervals for pricing purposes. Usually this has been done by posts of many designs, but sometimes it was done by way of plates on walls or paint marks.

Today the mileposts have principally an infrastructure engineering and operational relevance, and in spite of most projects being designed and planned in metric form, details of speed restrictions and location of infrastructure are published based on miles and chains. There are 80 chains to a mile. Thus a quoted distance of 83 73 indicates 83miles and 73chains which converts to 83.91miles.

Present-day milepost series reflect the piecemeal and haphazard development of the British railway system in the 19th century. Whilst improvements to routes have been made, lines are rarely re-posted, so there can be discrepancies in the totality of the route and changes to milepost series along it. Details are given in the RPS Distance Charts.

Mileposts come in all shapes and sizes, and examples are shown on the RPS web-site (www.railperf.org.uk). Some types are easy to spot, others are infuriatingly difficult to see, particularly at speed, when they are dirty, hidden by vegetation, or in poor lighting conditions. Examples are Shenfield-Norwich and Darlington-Newcastle. Mileposts are generally on one side of the track only, and details are shown in the RPS Distance Charts. Generally, mileposts can be found on the "down" side, except those of the former Great Western and Midland Railway. Again, details are shown in the RPS Distance Charts.

London Underground lines are posted in kilometres only, apart from the Metropolitan line. Certain other lines in the UK (e.g. Berwick-Newcastle) have kilometre posts as well as mileposts.

Unfortunately, not all mileposts are accurately placed and some are missing. The causes of mis-posting include:

- The zero point is not where one would expect it to be: for example the ex Midland Railway posts from Derby to Westerleigh are measured from London Road Junction at Derby, rather than the centre of Derby station, and the Great Western mileages are based on the boundary of railway property in Praed Street, Paddington..
- The post is misplaced by accident or deliberately, for example because it might obstruct a level crossing.
- Mis-measurement. There are notorious examples where routes have been poorly surveyed. The most famous routes in this regard are the Waterloo to Exeter and Basingstoke to Southampton lines, resulting in a small cumulative error over a long distance. Also the West Coast and Great Eastern main lines.
- Re-alignment. Where tracks have been re-aligned to straighten out curves, errors between successive mileposts may occur.

Affected routes are described in the RPS Distance Charts. The recorder needs to be aware of the location of these problems as they may affect the accuracy of the log.

2.13 Choice of timing points

Timing points are used to break up a log into a series of passing times that are useful in comparing journeys in terms of time and speed.

The choice of locations where passing times are taken should be governed by the golden rule of train timing:

Record a precise time at a precise point.

Note the emphasis on a precise point rather than a precise distance. It is vital that the timing point is known with precision: trying to ascertain the centre of a 10 chain platform can result in timing inaccuracies of several seconds, but if the time is taken at the station footbridge, a precise time can be taken every time. Similarly, taking a large station building as a timing point should be avoided in favour of a carefully defined point on it (eg station exit).

Whilst the choosing and frequency of timing points should be a matter of personal taste, RPS Distance Charts indicate suitable points, with distances. However, as a minimum, it is suggested that all open stations, principal junctions, scheduled timing points, summits and significant gradient changes should be included. It is recommended that timing points are no less than one minute apart, that RPS points are used wherever possible, and the passing point included in the log (eg fb, lc). Logs using only Mileposts as timing points are acceptable.

For subsequent verification, the more points included in the log the better, although timing points less than one minute apart should be avoided as, at high speeds, calculated average speeds may appear inaccurate as times even to half a second may not be sufficiently accurate.

2.2 Gradient data

To enable comparison between performance on different routes, it is necessary to consider the effect of gradient. The best source of British data is the “Gradient Profiles” book, reprinted occasionally by Ian Allan. Elevation data is required for power output calculations

2.3 Traction/rolling stock data

In assessing performance, weight and power need to be considered. Weights posted on rolling stock may not be sufficiently accurate. More reliable information is available for locomotives and coaching stock from “Platform Five” publications.

2.4 Equipment required

The equipment required is:

- at least one stop watch. A spare in case of failure is useful. This should be of a digital electronic type. The following guidance may be useful in considering a suitable stop watch:
    - Avoid watches that do not display times above, say 30 minutes, or round in whole seconds after a specific time.
    - Ensure there is a lap facility which allows time to be frozen. This enables time to be recorded accurately before resetting and looking for the next milepost.
    - There should be continuous display to 0.1 second or better.
      Further advice on stopwatches is contained on the RPS Web Site.
    - The RPS also recommends the use of a handheld GPS receiver. Full details of how GPS are best used can be seen in Section 7.

Equipment best avoided is:

- Analogue watches generally.
- Using a second hand on an analogue wrist watch due to the inaccuracy of recording to at best one second.
- Using a second stop watch instead of a lap facility will lead only to confusion and an increased number of errors.

3.0 Preparation for the journey

The following are required for the journey**:**

- a stop watch, as described in 2.4 above. A back-up stop watch may be useful if the battery fails. A stop watch on a digital wrist watch may be sufficient.
- An ample supply of pens and paper e.g. ruled notebook or cash book
- a clear and simple method of laying out notes during the course of the journey. A grid of timing points may be useful.
- an accurate distance chart and possibly gradient profile for the route being timed.

4.0 THE JOURNEY ITSELF

4.1 Recording times using mileposts

The recorder should find a window seat on the milepost side of the train, preferably facing the direction of travel. The stop watch should be started at the first movement of the train, and the actual clock time of departure should be noted. Stopwatches should be zeroed following false starts and drawing-up manoeuvres but should not be zeroed for an operational or signal stop that is not for the use of passengers . Recorders should note times (to the nearest tenth or hundredth of a second) at as many mileposts and timing points as possible using the lap facility of a single stopwatch. This allows the recorder to spot serious timing or milepost errors.

An example follows:

Location	Time (m s.dd)	Av speed (mph)
READING	00 00.00	
mp 26	9 01.49	
mp 25 ½	9 21.29	90.9
mp 25	9 41.20	90.4
mp 24 ½	10 02.55	84.3
Maidenhead	10 11.00	
MP 23 ¾	10 31.16	94.4
MP 23 ¼	10 51.09	90.3
MP 22 ¾	11 11.27	89.2

Note: the average speed reflects the average speed between the milepost on the line and the previous line.

It would appear that the train is cruising at about 90mph and that the time at mp24½ is incorrect, which results in the two erroneous speeds of 84.3 and 94.4mph. Consequently the time at mp 24½ should be ignored. Without continuous lap recording, the error may not have been apparent. This type of error may be picked up on the journey but is more likely to be detected during log preparation; in either case the above statements are true.

From a single log it is difficult to determine whether this type of problem is due to incorrect positioning of the milepost or recorder-error. However if this speed variation is consistent with other logs, whenever mp 24½ is included, then it likely to be a milepost- positioning error.

Whilst times at Mileposts should be recorded to either tenths or hundredths of second level accuracy, times at passing points only need to be recorded to the nearest half-second.

The elapsed time at which the brakes are applied should be noted, together with duration of stops and the cause of checks if known.

4.2 Timing trains after dark or with restricted visibility

GPS is ideal in these conditions (see 7 later), but even without GPS, it is still possible to record logs in sufficient detail to assess the quality of the running. At night, the recorder can discern many line-side features. By taking passing times at these points, to the nearest 0.1 second, it is usually possible to work out a series of average speeds from timing points closer together than conventional logs. The Society has been expanding its Distance Charts to include these detailed timing features.

However, it is easy to become disoriented during long periods of darkness without obvious reliable confirmation of location, and the longer the distance between points, the less accurate the indication of actual speed.

5 TURNING A JOURNEY INTO A LOG

What the recorder can accomplish on the train is dependent upon the extent of electronic assistance that is available and the mental dexterity of the recorder. As a minimum, it would be a listing of passing times at mileposts and timing points.

5.1 Speeds from milepost readings

In estimating speeds, recorders should try to ensure that speeds quoted are accurate to the nearest 1mph. Areas that need to be considered are:

- Average speeds

Recorders should appreciate that all milepost speeds are averages, and that maximum speeds may be understated and minima overstated. Interpolation can be used to calculate speeds at passing points - see later

- Assessment of high speeds

One has to ensure that the distances over which milepost timing are recorded are sufficiently long that likely recording errors do not significantly affect the average speed between mileposts. For instance, when travelling over, say 60mph readings should be taken every half-mile and over 100mph every ¾ mile assuming gradient is constant.

- In practice, the frequency of milepost recordings is often limited by the stamina of the recorder. Notwithstanding what has been explained above, however, the more readings taken the better.

- braking - the speed at a timing point while a train is braking is fairly meaningless and a note “braking” in the log should be sufficient. However, the time when braking commences should be noted.

5.2 Potential inaccuracies

- Reaction times

It is thought that a reaction time of 0.1 second is realistic for random events. However mileposts can be observed ahead, which may improve accuracy. Similarly, calculated speeds results arise from two readings, so the inaccuracies in the first reaction time may mirror those of the second.

- Parallax errors

The watch should be stopped when the post is directly level with the recorder. This may be difficult, particularly when seated backwards to the direction of travel, and in the vicinity of multi-track sections.

- slight delay in pressing the button

This may be due to a delay in sighting the milepost, or if there is "play" in the stop watch button.

When a recorder feels that a reading may be unreliable, he should make a note, and examine the resulting data later, disregarding it, if errors are indicated.

5.3 The Calculation of Speed

Speed is defined as distance/time. If the distance between two timing points is expressed in decimal mileage, the formula is:

$$\text{Average speed} = \frac{3600 \times s}{t}$$

where:

s is the distance between timing points (decimal miles)
t is the time taken in seconds.

The formula works equally well for kilometres as for miles.

In these days of pocket calculators, this is probably the simplest method of calculation in view of the complications of calculating distances in miles and chains (1/80 of a mile). However, minor rounding errors can appear when decimal mileages have been calculated from miles and chains which have been rounded to two decimal places.

For milepost timings, speeds can be calculated from the above formula and using .25miles in variable s. If the readings are taken less frequently than ¼ mile intervals, the result can be multiplied by 2 for half mile readings, 3 for ¾ mile readings and so on.

Using chains, the formula is :

$$\text{Average speed} = \frac{45 \times n}{t}$$

where n = the distance between timing points (in chains) t = the time taken between timing points (seconds)

If a distance of 1mile 27chains is covered in 1m12.6secs, n = 107 chains, t = 72.6 secs and using the above formula the average speed would be calculated as 66.3mph

6 LOG PRESENTATION

6.1 Standard Log

A standard RPS style of log presentation has evolved, and although each recorder has his preferred method, a standard format is required to produce consistency, and avoid the need to edit every log before publication. A recommended log template is shown below and on the RPS website (www.railperf.org.uk) and is explained:

TABLE			
Run No. Date/day Train Motive Power Load (tons) Weather Rec/Pos/GP S?			
Miles	**M C**	**Location**	**???** **Sch m s mph *Ave***
0.00			
0.00			
0.00			
0.00			
0.00			
0.00			
0.00			

6.2 Log headings

Run no	1	
Date/day		Sat 2-Jun-1990
Train		0855 Swansea to York
Motive power		47830
Load(tons)/power:weight		6,199/220/340,7.5hp/ton Mk2 ac
Weather		Dry, warm, no wind
Recorder/Position/GPS?		F Collins,2/7, N

Run no

This may be a filing/indexing record for the recorder, or in an article, a cross reference from the text to the table.

Date

The day of the week is necessary, because of the differing schedules at weekends.

Train

The originating and terminating points of the train should be stated, together with the starting time from its original starting point..

Motive power

Details of loco names, sector code/TOC are optional, but should relate to the situation at the date of journey, rather than at the time the log was published. Where appropriate, the DVT number and whether the locomotive is leading or propelling should be noted.

Load

For all runs, the recorder should ascertain the weight of the train, including the locomotive, in imperial tons. This may be from the plated weight of the stock or from published information such as Platform 5 Guides. The number of passenger coaches should be shown. HST power cars are assumed to be locomotives, but driving motor coaches for DMUs and EMUs should be counted as coaches. A train led by a DVT comprising 9 coaches would be counted as 10.

The tare weight- the coaching stock (including non-passenger carrying vehicles) - as described above, followed by the gross weight - including passengers and luggage - and then the total weight - including the locomotive - are shown. (The gross weight will include DMU power cars)

The weight of the passengers is difficult to assess. An appropriate method is to calculate the number of seats on the train (determined from the Platform5 Multiple Unit or Coaching Stock Guide) and multiply it by the percentage of filled seats, and then assume 14 passengers per ton. The resulting gross weight is then rounded to the nearest 5 tons. Details of significant changes during the course of the journey should be assessed.

The power:weight ratio is to be encouraged. It gives an indication of the accelerative capacity of the train - the higher the ratio the more rapidly can the train accelerate. For diesel powered trains this is the total rating of all the engines (in horse power) divided by the total weight (including the locomotive) For electric trains the continuous power rating is used, rather than any short term rating (eg 10 minutes).

Coach type should be shown, as it is relevant in horsepower calculations.

Weather

Wind speed and direction, variable adhesion caused by poor rail condition, and the effect of temperature on ETS(ETH) demands, all affect train performance and should be recorded if relevant.

Recorder position

The recorder's position in the train should be specified in relation to the total number of vehicles in the train - including power cars and locomotives. In this example the recorder was in the first coach of the train. This is relevant in comparing logs when trains are passing timing points at slow speed. For instance, a 10 coach train passing point A at 90mph will take 5secs to pass the timing point. Passing point B at 10mph will take 45secs. The elapsed time between points A and B will vary by up to 40secs, depending upon where on the train the recorder is located. By noting the position, this variation can be taken into account and may be relevant when making comparisons.

GPS?

This indicates whether the speeds are derived from GPS. If so, they are likely to be reflect more accurately the minimum and maximum speeds of the train.

6.3 The log itself

Miles	M c	Location	S ch	MinSec	Mph	Average
0.00	42 24	BIRMINGHAM New St	0	0 00	RT	
0.69	41 49	Proof House Jn		2 14½		*18.5*
1.55	40 60	Landor Street Jn		3 38½	40	*36.9*
2.51	39 63	Washwood Heath No 1		4 57½	55	*43.7*
3.81	38 39	Bromford Bridge		6 11	75	*63.7*
				tsr	40	
5.30	37 00	Castle Bromwich		7 59	47	*49.7*
6.30	36 00	Castle Bromwich Jn		9 03	65	*56.3*
7.63	34 54	Water Orton		10 10	78	*71.5*
	33 32					
9.03	32 00	MP		11 12	84/89	*81.3*
10.53	30 40	MP		12 13½	88	*87.8*
11.78	29 20	Kingsbury		13 06	84/82	*85.7*
		signal stop		16 05		
				18 45		

and so on ….

Mileages

Two columns should be shown. The first column is the decimal mileage, stated to two decimal places. This can be the distance of the timing point from the previous stopping point, or if taken from the Society's distance charts, it may be the starting/finishing point of that particular chart.

The second column indicates the position of the timing point in miles and chains relative to the milepost series. Most logs these days are recorded to the nearest chain.

A change or discrepancy in milepost series, which occurs at Water Orton as above, should by a horizontal line in the miles and chains column at the point where the variation occurs. The distance in miles and chains at this point should be shown for both milepost series.

At any station stop, the distance should be the point at which the train has stopped. Consequently the platform number should be quoted, where it is relevant for comparison, to enable the distance to be calculated. The RPS Distance Charts normally give this information for combinations of train formations and platforms at stopping points and termini.

When using a platform with buffer stops a terminal allowance is taken into account. This is necessary for accurate calculation of start/stop average speeds.

Location

Station stops or major stations can be shown in capital letters. The platform information is relevant if there are different speed restrictions into each platform. The RPS distance charts have recently incorporated more detailed data. Consequently, you may wish to add the timing feature to the log (eg fb,lc,ob). The frequency of timing points should be no less than a minute apart, at normal line speeds.

Schedules

The recorder should extract the scheduled time and whether it's the working timetable (source: Network Rail) - preferred - (wtt), national public timetable (ptt), or TRUST-derived.

Times

The use of times to the nearest half-second, or better, eliminates inaccuracies in the average speed calculations between timing points.

Temporary speed restrictions (tsr)

Where a temporary speed restriction, denoted by line-side signs, causes the speed of the train to vary from the norm it should be noted in the log. If known, the actual speed restriction being enforced should be noted. The minimum actual speed recorded that the train negotiated the restriction should be shown. The tsr may be shown either in the speed column or given a separate row in the log.

Permanent speed restrictions

Permanent speed restrictions, denoted by line-side boards, need not be identified, although they should be apparent from the speed variations.

Signal checks

If a train slows because of signals this should be shown in the log, either in the speed column or in a separate row. Should the train stop out of course, i.e. not at a booked station then the elapsed time for the stops and restarts should be shown. When precise minimum speeds are not known because of the braking capabilities of the train between two mileposts, an estimate - to the nearest 5mph should be given. When a modern train is braking heavily at a timing point, no reliable speed can be assessed. In these circumstances “braking” rather than an estimated speed should be shown

Speeds

Speeds from mileposts are used to determine the assessed speed at timing points based on average speeds between mileposts. They should be quoted to the nearest whole mile per hour. Where two speeds are shown, the first shows the speed at that timing point, and the second or third shows the fluctuations in speed between that timing point and the next. In the earlier example, the speed at mp 32 was 84mph, before the train accelerated to 89mph and passed mp 30½ at 88mph. (highlighted in bold on log)

Average speeds

The average speed between two timing points should be calculated as explained earlier and shown in italics to one place of decimal. Any average speed that does not fall between the minimum and maximum speeds between the two points should be examined. The average speed between Point A and Point B should be shown on the Point B line. The average speed is used for checking and will not necessarily be published.

Punctuality

This should be shown in the speed column where a train has a scheduled stop. If the comparison is with a public timetable it should be shown to the nearest minute and against a working timetable to the nearest half minute. For example 2L indicates two minutes late and 2E two minutes early, RT right time.

Uncertainties

There can be instances when the recorder is not completely sure of the accuracy of certain aspects of the data. Examples are

- where the speed is uncertain because of the variability of speed between the two milepost readings or where the train is accelerating/decelerating. Don't quote speeds when the train is braking heavily.
- with modern types of rolling stock, and their lack of openable windows, it may be difficult to ascertain the reason for the braking in which case just record the brake application and the reduction in speed.

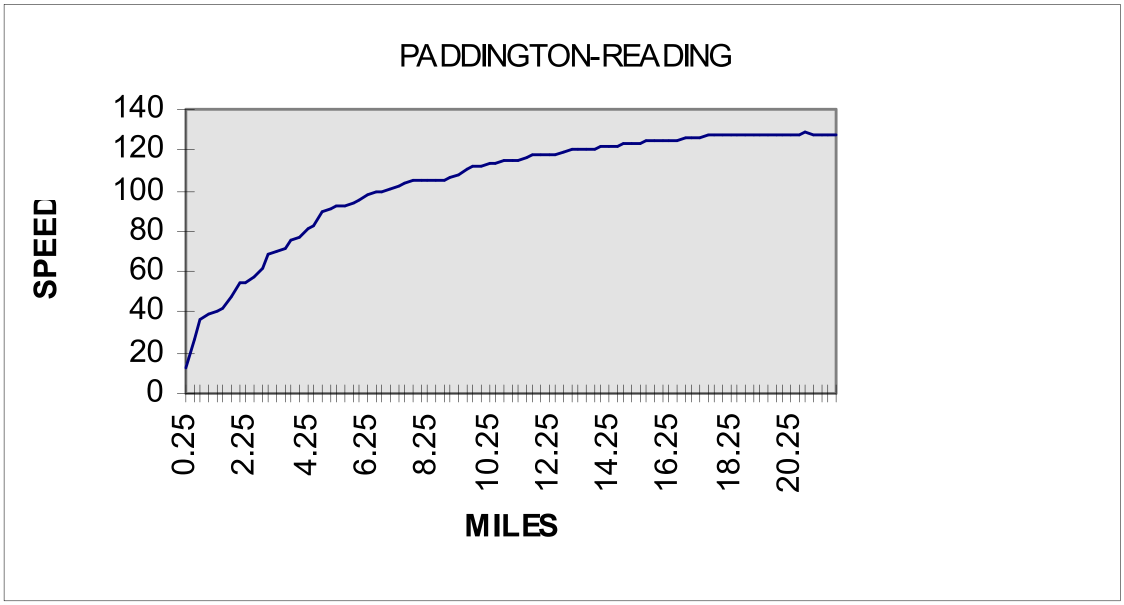
In cases of uncertainty, speeds should be excluded.

6.4 Graphical presentation

This can be useful:

- to show log speeds at a glance
- to compare two different logs in terms of speeds and acceleration/deceleration
- to compare line speed with actual speed.
- to highlight the effect of temporary speed restrictions on performance

The disadvantage is that individual maximum/minimum speeds may not be accurately discernible from the graph due to the wide variation in speeds to be scaled within the graph.



7 TECHNOLOGICAL DEVELOPMENTS

7.1 Using Global Positioning System (GPS)

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Perhaps the most radical - and controversial - change in train timing technique in recent years is GPS. It is a system of 27 navigational satellites which were originally launched by the American military, but now available to all. Of these satellites, half are located in the Northern Hemisphere and half in the Southern, and not all are visible at any one time. In its most basic usage, it is a means of recording the speeds of the train. In its more advanced aspects, it can locate timing points, can download data to a pc and export it to a spreadsheet

The benefits of GPS are:

- increased accuracy of train speeds peaks and troughs (milepost speeds are averages, whilst GPS speeds are instantaneous)
- opportunities for detailed recording in the hours of darkness and times of restricted visibility using GPS speeds and waypoints
- the ability to download detailed data to PCs for further analysis and, ultimately to produce logs.

Readers should not buy one of these navigators, jump on a train and start recording speeds without being aware of their occasional inconsistencies. These chiefly relate to the consequences of poor signal strength due to the fact that a railway carriage is not an ideal environment to receive signals.

These problems manifest themselves in the form of:

- **The signal is actually lost (for example due to tunnels or poor signal strength**)

The recorder is aware that the signal has been lost, and may have been inaccurate for the previous thirty seconds, but he may not have back up methods available to ascertain speed during this period.

Readers should be aware that GPS does not work in some modern stock due to a coating process applied to the windows.

- **The displayed speed may be inaccurate but the recorder is unaware of it**

A filter operates which suppresses speeds which are significantly different from the immediately-preceding speed. This is due to possible inaccurate speed readings when incorrect positions are being read by the GPS which would result in the display of erroneous speeds. Similarly, speeds of accelerating and decelerating trains may also be suppressed. The signal may be lost and subsequently regained within the thirty seconds and the screen will "freeze" until the signal is regained. However the recorder may not be aware of this. Downloaded tracks to PCs are not filtered in this way, so evidence of acceleration and erroneous speeds are apparent. Whilst incorrect speeds can be discounted, the recorder will not be aware of the correct speed.

Readers should not assume that, due to these problems, recorders should stop using GPS; they should try to corroborate the results of GPS with conventional data. The methods are described later.

RPS Recommendation: Corroboration of GPS outputs is important. Members are strongly recommended, where possible, to continue recording stopwatch milepost readings, noting the GPS speed at each post. Comparing average speeds between timing points with GPS speeds is just as relevant for a GPS log. GPS units are a useful tool and they fulfil a role supporting conventional train timing equipment. A perfect data source does not exist, so train timers should ensure that the technology available is used to maximise the accuracy of the data.

7.11 Choice of GPS Machine

Advice on the choice of suitable GPS machines can be found on the RPS web site. The choice of GPS machine is mainly related to the amount one is prepared to spend. However, the more expensive products tend to have a map facility which may be less useful for train recording than for, say, walking or sailing. Most other products are fairly similar, but consideration should be given to:

- the amount of data that can be viewed on a single screen. It is best to avoid continually switching from screen to screen. Can the user define the fields he requires?
- whether an accurate stop watch facility is available
- how severe is the filter? A product suitable for walkers may not react promptly to acceleration and deceleration of trains.
- can the data be downloaded?
- whether the location of satellites is shown
- if tracks are required, is frequency user-definable?. A track is a history of the data collected by the machine in the form of positional data, times, speeds and distances travelled. It normally cannot be accessed from the GPS, but can be downloaded to the map software, and then exported into a spreadsheet to produce logs. The frequency is relevant as longer periods may result in less-frequent readings than data from mileposts, and also, the speeds

are calculated assuming travel is in a straight line. On curves, this may understate the actual speeds if readings are not taken frequently.

- How many waypoints and tracklog readings can be stored on the GPS unit?
- In view of the problems relating to signal quality, how effective is the fitted antennae and can an external one be attached?

7.12 Use of GPS data for distances: GPS should not be used for distance data, and GPS altitude data is particularly inaccurate

7.13 Recording times using GPS

Times should not be recorded using a GPS unless the machine comes complete with a stopwatch facility accurate to 0.1 seconds.
On lines with numerous tunnels and, consequently, where continuous signal retention is unlikely, recorders may wish to abandon GPS on these sections, and rely on timing from mileposts.

7.14 Using speeds taken from GPS readings

Speeds can easily be taken from GPS navigators. To establish intervening maximum and minimum speeds, it may be advisable to note readings every, say, 10 seconds in the following fashion:

Time	Speeds (mph)					
Mins						Secs
	0	10	20	30	40	50
2	60.2	63.4	65.4	67.2	70.4	72.2
3	72.2	72.2	79.1	81.1	83.3	84.2
4	85.1	82.3	80.2	82.4	83.4	84.5

This method of tabulation may prompt the recorder to consider whether speeds have been suppressed as explained earlier. In the above example the speeds at 3m00s and 3m10s look suspicious, and may indicate that the screen “froze” until a signal was re-established at 3m20s. In these circumstances, if a speed is required at a timing point where the speed is suspect, or the signal has been lost, recorders may wish to estimate the speed and enclose it within brackets on the log.

If it not possible to compare milepost with GPS speeds - for example at night or due to poor visibility) then, as a minimum, the average speed between timing points should be checked to ensure it lies between the minimum and maximum speed.

And finally ….

We hope that this introduction has given readers unfamiliar with timing techniques the information they need to produce logs. For those members with experience of traction performance, we hope it has given them information that will enable them to improve their recording techniques.

The Society is building up a library of books on traction performance. Lists of books available for borrowing are listed frequently in “Milepost”

If you require further information, or have suggestions for future improvements in this publication, please contact the committee members of the Railway Performance Society (Addresses in “Milepost”)