



General Principles of Traffic Control by Light Signals Part 1 of 4



This document is Part 1 of Traffic Advisory Leaflet 1/06. It should be read in conjunction with Parts 2, 3 & 4. The Reference section is in this Part.

INTRODUCTION

The primary purpose of traffic control by light signals is to separate conflicting traffic by the division of time, within the available road space, in a safe, efficient and equitable manner. The term “traffic” includes all road users: vehicles, (including cycles), pedestrians and equestrians. Conflict at a junction is manifested as an increase in delay and/or accident rate.

At a signal-controlled junction, vehicular traffic is permitted to flow in a strictly controlled manner. The traffic flows, available road space, layout and stage

sequences will all affect delay. The successful installation will impose the minimum delay on all traffic, consistent with safety.

The designer should have a firm grasp of the relevant current legislation and advice/guidance. The “umbrella” document is TA 84¹, “The Code of Practice for Traffic Control and Information Systems”, which encourages consideration and documentation of the various safety aspects. Traffic Advisory Leaflet (TAL)², “Traffic Light Signals - Relevant Publications”, lists both those documents directly associated with the subject and others which practitioners should have knowledge of.

General layout matters are covered in TD 50³, “The Geometric Layout of Signal-controlled Junctions and Signalised Roundabouts”. This takes the designer

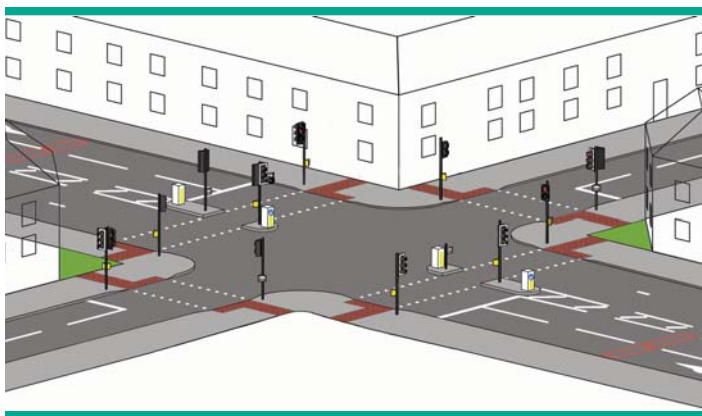
through the early considerations, such as the intervisibility, lane widths, swept paths of vehicles etc. TD 50³ was written for trunk road junctions and although the advice given will also be applicable to many other junctions, there will be exceptions. For example, some junctions are signal-controlled because there is poor intervisibility, which cannot reasonably be improved and a priority junction would not be safe. Therefore, some of the advice given in TD 50³, on subjects such as intervisibility needs to be considered pragmatically. Decisions may be justified because of the existing/desired topography, or to help deliver a desired design speed. The Manual for Streets, currently in preparation, is developing this approach, adopting a different approach to road design by creating environments which dictate the prevailing speed of vehicular traffic rather than try to accommodate it.

This document follows on from TD 50³, considering the detail. It is necessary to read TAL 5/05⁴, “Pedestrian Facilities at Signal-controlled Junctions” with this document and there are others, such as TAL 2/03⁵, “Signal-control at Junctions on High-speed Roads”, which should be referred to as necessary.

Compared with other western countries Great Britain (GB) has a good accident record at signal-controlled junctions. This is certainly in part, if not mainly, due to a consistent system of signalling for a given circumstance. It is important that all displays must be clear and unambiguous.

SIGNAL POSTS

The standard signal head is mounted on a post, within the height limits set in the Traffic Signs Regulations and General Directions (TSRGD)⁶. However, because of poor sight lines caused by the geometry of the approach, or by high vehicles blocking visibility at some point on the approach, designers may need to consider a supplementary signal. This could be either by using a tall post, with a second signal above the standard one, or by installing a mast arm signal over the carriageway. However, the aim should be a sufficiency of signals, not a surfeit. As in all traffic management, a proliferation of signs/signals can lead to confusion and ambiguity. Tall post signals need authorisation if they are above the maximum height in



TSRGD⁶. The designer needs to check that the posts to be used are structurally approved for the specific design (see TAL 2/03⁵).

Designers should consult TA 89/04⁷, “Use of Passively Safe Signposts to BS EN 12767⁸”. BS EN 12767⁸: Passive safety of support structures for road equipment - Requirements and test methods, is voluntary and provides a means of classifying items of roadside equipment in terms of the likely severity of injury they might cause if a vehicle collides with them.

Sockets are available for posts so that they can be removed easily for wide loads, ceremonial occasions etc. The socket arrangements come complete with electrical plug/socket connections.

It is normal to number posts, at least on the design drawing. A standard convention should be adopted, say, starting at the controller and working clockwise.

SIGNAL DISPLAYS

Traffic signal displays are provided under powers contained in the Road Traffic Regulation Act⁹. They must comply with TSRGD⁶ which calls for some equipment to be approved and the relevant specifications are listed in MCS 206¹⁰ “List of Drawings, Specifications and Instructions”. MCS 215¹¹ “Traffic Signal Equipment on all Purpose Roads - Summary of Approval Status” gives details but advice on individual approvals can be sought from the Highways Agency. Any use of signals not specifically covered by the above documents is unlawful unless specifically individually approved/authorised as appropriate.

Traffic control is by means of red, amber and green light signals, supplemented by additional green arrow light signals and regulatory signs as necessary (but see section on wig-wag and tram signals). Individual elements in a signal head are known as “aspects”. In Europe the term used is more often “optical unit”. (NOTE the colour “yellow” referred to in European Standard (ES) EN 12368:2000¹² is known in GB as “amber”.) TSRGD⁶ gives details of the performance level within the ES¹² for signal heads. TSRGD⁶ requires all junctions to have at least two signal heads per approach.



One signal head is normally placed on the nearside and is known as the primary signal. Each approach has a transverse stop line associated with the primary signal indicating the place at which vehicular traffic must stop. The signal must be beyond the stop line, as seen for an approaching vehicle and before pedestrian crossing studs if provided. The minimum distance from stop line to studs is 3 metres, with the post to studs distance set so that pedestrians can easily reach the push button, normally 0.5 metres. Although there is no legal maximum at junction signals, care must be taken not to jeopardise intervisibility, or confuse road users. There can be a second primary signal, sometimes known as the duplicate primary. These are on the offside, possibly on an island.

Signal heads beyond the junction are known as secondary signals. The displays must have the same information as the primary and may have additional information, which must not conflict with that shown on the primary. In certain circumstances it may be undesirable, or impracticable, to position the secondary signal beyond the junction. On these occasions the secondary may be on the entry side of the junction, beyond the stop line and primary positions and preferably on the offside. This is known as a closely associated secondary.

There must always be a primary signal but the required second signal can be any of the other types described. The important test for sufficiency of signal heads is to be found in Local Transport Note 1/98¹³, "The Installation of Traffic Signals and Associated Equipment". Other references can be found in TAL 2/03⁵, "Signal-control for high-speed junctions" and Local Transport Note (LTN) 2/95¹⁴, "The Design of Pedestrian Crossings".

Signal heads may be provided with a black backing board, known in parts of Europe as a background screen, which enhances the conspicuity of the signal, especially if there are background distractions: advertisements, street lighting, general shop front "noise" etc. Legislation allows for a white strip around the backing board. Previous backing boards extended the width of the signal significantly, potentially causing problems at constricted sites. Legislation now permits white borders to be fitted directly to signal heads. The white strip alone will help to enhance the definition of the signal head. If the signals are not working for any reason this is particularly important. A reflective white border is particularly helpful in the case of a local power failure, or in areas with no street lighting.

In the context of this document, an arm is one road forming part of the junction; an approach is that part of the arm which carries traffic towards the junction and a traffic stream consists of vehicles in one or more lane, on the same approach, which, when they have right of way, will move in the same direction.

GREEN ARROW LIGHT SIGNAL DISPLAYS

The significance of a green arrow is that drivers can proceed only in the direction of the arrow (assuming no other green signal) and continue through the junction in that direction. See TSRGD⁶ for the legal definition. If there are other green signals these will have separate meanings.

When green arrows are used, drivers have come to expect an exclusive right of way. It is therefore strongly recommended that when green arrows, especially for turning traffic, are displayed there should be no conflicting movements.

Substitute Green Arrow Signal

A green arrow can be fitted in place of the full green in a three-light signal head. It may indicate any movement through 180° above the horizontal. A green arrow in this position must always be preceded by a red + amber and terminated by amber, or full green.



Additional Green Arrows

Additional green arrows may be fitted in any of the positions indicated in TSRGD⁶.

A filter arrow is a green arrow displayed on its own, normally a left hand arrow, with an associated red signal. It is not preceded by a red + amber and is followed by a full green. These are commonly run in parallel with a non-conflicting right turn from the opposing approach.

An indicative arrow is a green arrow displayed with a full green, conventionally displayed only in the secondary position. It is preceded by a red + amber, or full green and followed by a full green, or amber. A typical use would be an early cut-off sequence, see later reference.

Amber Arrows

Some drivers can have problems at sites where a common stop line is shared by lanes, which are being separately signalled with green arrow signals. It is thought that they anticipate that an amber signal preceding, say, a green arrow for a straight ahead movement is that for a right turn. The driver may then move off, unlawfully, against the amber signal and turn right, a movement which may endanger both that driver and others.

Research was carried out with replacing the amber signal with one showing an amber arrow. However, although this did reduce the number of incidents involving the red/amber period, at some sites it increased the number of drivers failing to stop during the amber period.

An Intelligent Amber Arrow, a signal showing an amber arrow before the green arrow but a full amber before the red was developed and tried at a number of sites. This did reduce the number of drivers failing to stop during the amber period. However, the future of this development is unsure and potential users should contact the Department before incorporating amber arrows in their design. Site authorisation for the use of amber arrows would also be needed.

SIGNALS FOR LIGHT RAPID TRANSIT SYSTEMS (LRTS OR TRAMS)

Trams are now well established in a number of towns and cities. The Railways Inspectorate (HMRI) should be contacted at an early date if a system is being considered.



For trams at signal-controlled road junctions, signals to one of the variants of diagram 3013 of the TSRGD⁶ are used. The tram signals are often mounted alongside standard signal displays as shown in TSRGD⁶. Facilities for pedestrians crossing at signal-controlled junctions and elsewhere on the system need to be considered at the start of the project.

Although signals are not now required to be type approved, specification TR 2514¹⁵ does give the requirements for light signals for the control of trams. The specification shows the lines in diagram 3013 as a sequence of discrete “spots”. This arrangement does not need authorisation.

Other tram signals used on the system are not necessarily seen by vehicle drivers. However, if they are, signals such as “point indicators” will need authorisation, as they are not prescribed in TSRGD⁶. Advice on the procedure for authorisation can be obtained from the local Government Office.

WIG-WAG SIGNALS

Signals to diagram 3014 in TSRGD⁶ are prescribed “for the control of road traffic at level crossings, swing or lifting bridges, tunnels, airfields or in the vicinity of premises used regularly by the fire, police or ambulance service vehicles”. The signal heads need to be ES compliant, as specified in regulation 39 of TSRGD⁶. A TAL specifically on the use of wig-wags will be published shortly.



It is important to note that although some specified vehicles may pass a red signal displayed by an assembly in the diagram 3000 series, there are no exceptions for drivers to pass a red signal displayed by one to 3014.

The specification is TR 2513¹⁶ “Performance Specification for Wig Wag Signal Control System.”

For level crossings, the HSE publication “Railway Safety Principles and Guidance, Part 2, Section E, Guidance on level crossings”¹⁷ is the source document. The Railways Inspectorate (HMRI) must be consulted if any work is planned near level crossings.

There are situations where the standard 3014 signal cannot be used because of a lack of space. A narrower version can be used but will need authorisation. A drawing NP 3015 is available from the Traffic Signs Technical Advice Branch of the Department. It is essential that signals used display the same layout as diagram 3014 and not a three-in-line assembly as in the diagram 3000 series.

Signals for the exit, say, from a fire/ambulance station show blue, or white with amber aspects. These are not visible to the public highway. See TR2513¹⁶ for details of this and call out switches etc.

SIGNING

A review of the existing signing should always be part of the new/modified signal layout design. Careful combination of signs onto a common background, for example, will cut clutter and give a clearer message.

Regulatory

There is no requirement for erecting a sign to diagram 606 where an exclusive traffic movement is required at the signals, as indicated by a substitute green arrow. However, if there is a Traffic Regulation Order (TRO) associated with the junction it must be signed. Regulatory signs may be used in conjunction with signal displays to indicate movements that are restricted.

TSRGD⁶ refers to the type, illumination requirement and position of the signs.

Prescribed subplates in TSRGD⁶ can also be used to indicate exceptions listed in the TRO. These are circular and allow fitting in a standard signal housing. However, the size of lettering on some is smaller than would otherwise be used.

To give drivers every opportunity to comply, the lettering size (x height) should be commensurate with the 85th percentile speed, as shown in Chapter 3 of the Traffic Signs Manual¹⁸. If it is not possible to use this size in the signal display, other methods should be used instead, or in addition.



One method is to use advance signing, say, to Diagram 818.2, TSRGD⁶ and a standard plate sign at the junction.



Informatory and Warning

Signs on the approach to and at the junction are an important part of the overall design. Regulatory signs have already been mentioned. Informatory and warning signs also need careful consideration:

- Signals work by allocating time but often the design also allocates space, say, by providing separate lanes for left and/or right turning vehicles. To maximise the junction capacity it is important to provide informatory signs to get drivers into the correct lane. This also reduces lane changing near to the junction with the associated accident potential.
- Warning signs (see individual guidance in Chapter 4¹⁹ of the Traffic Signs Manual) can be needed for the signals themselves, diagram 543 or a 584/584.1, or for other potential problems, such as diagram 530 for a low bridge ahead, or a combination of diagrams 520 and 521 where a dual carriageway ends after the junction.
- Road markings - see Chapter 5 of the Traffic Signs Manual

Apart from the possibility of signs directly associated with the installation, such as to diagram 543.1, there should be no other signs mounted on the signal post. Other signs would inevitably attract a driver's attention and it is important that this is concentrated on the signal displays.

STREET LIGHTING

Signal-controlled installations will only work efficiently if treated as a part of the whole and not as a separate entity. When introducing signal-control, the introduction of, or alteration to the street lighting should be considered as part of the design. If there are pedestrian facilities street lighting is essential.

The type of street lighting should be considered. Low pressure sodium, with its yellow source is unsuitable if it acts as a backdrop for the amber (yellow) signal. High pressure sodium, which has a white light, gives better contrast.

BS 5489²¹, Road Lighting is a general starting point for design, which should be undertaken by a qualified lighting engineer.

REFERENCES

All the listed HA specifications will be replaced and renumbered in the near future. Designers should refer to the HA.

- 1 TA 84, The Code of Practice for Traffic Control and Information Systems, Design Manual for Roads and Bridges (DMRB), Vol. 8, Section 1. TSO.
- 2 Traffic Advisory Leaflet (TAL), Traffic Light Signals - Relevant Publications. DfT.
- 3 TD 50/04 The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts, DMRB, Vol. 6, Section 2. TSO.
- 4 TAL 5/05, Pedestrian Facilities at Signal-controlled Junctions. DfT.
- 5 TAL 2/03, Signal-control at Junctions on High-speed Roads. DfT.
- 6 The Traffic Signs Regulations and General Directions 2002. ISBN 0-11-042942-7. TSO.
- 7 TA 89/04, Use of Passively Safe Signposts to BS EN 12767, DMRB, Vol 8, Section 2, TSO.
- 8 BS EN 12767, Passive safety of support structures for road equipment - Requirements and test methods, BSI.
- 9 Road Traffic Regulation Act 1984. TSO.
- 10 MCS 206, List of Drawings, Specifications and Instructions. HA.
- 11 MCS 215, Traffic Signal Equipment On All Purpose Roads.
- 12 European Standard EN 12368:2000. BSI.
- 13 Local Transport Note 1/98, The Installation of Traffic Signals and Associated Equipment. TSO.
- 14 Local Transport Note (LTN) 2/95, The Design of Pedestrian Crossings. TSO.
- 15 TR 2154, Light Signal for Control of Tramcars. HA.
- 16 TR 2513 Performance Specification for Wig Wag Signal Control Equipment. HA
- 17 Railway Safety Principles and Guidance, Part 2, Section E, Guidance on level crossings. HSE
- 18 Chapter 3 of the Traffic Signs Manual. TSO.
- 19 Chapter 4 of the Traffic Signs Manual. TSO.
- 20 Chapter 5 of the Traffic Signs Manual. TSO.
- 21 BS 5489, Road Lighting. BSI.
- 22 TR 2500, Specification for Traffic Signal Controller. HA.
- 23 BS 6100:1992 Building and Civil Engineering Terms. BSI.
- 24 MCE 0108C, Siting of Inductive Loops for Vehicle Detecting Equipment at Permanent Road Traffic Signal Installations. HA.
- 25 TAL 16/99, The Use of Above Ground Vehicle Detectors. DfT.
- 26 TAL 3/97, "The MOVA Signal Control System". DfT.
- 27 TD 35/91, "All Purpose Trunk Roads MOVA System Of Traffic Control At Signals". DMRB Vol.8, Section 1, Part 1. TSO.
- 28 TAL 7/99, "The SCOOT Urban Traffic Control System". DfT.
- 29 TAL 7/00, SCOOT Gating. DfT.
- 30 TAL 8/00, Bus Priority in SCOOT. DfT.
- 31 TAL 9/00, SCOOT Estimates of Emissions from Vehicles. DfT.
- 32 "A Review of Signal-controlled Roundabouts", Traffic and Safety Committee, Traffic Management Working Group. CSS.
- 33 LINSIG. JCT Consultancy.
- 34 OSCADY Optimised Signal Capacity and Delay. TRL.
- 35 ARCADY Assessment of roundabout Capacity and Delay. TRL.
- 36 PICADY Priority Intersection Capacity and Delay. TRL.
- 37 Road Research Technical Paper No. 56 - Traffic Signals, Webster and Cobbe, HMSO, out of print.
- 38 TRL Report RR67 The prediction of saturation flows for road junctions controlled by traffic signals. TRL

Details of Traffic Advisory Leaflets available on the DfT website can be accessed as follows: www.dft.gov.uk

From the DfT homepage, click on Roads and Vehicles, then Traffic and Parking Management and then Traffic Advisory Leaflets.

The Department for Transport sponsors a wide range of research into traffic management issues. The results published in Traffic Advisory Leaflets are applicable to England, Wales and Scotland. Attention is drawn to variations in statutory provisions or administrative practices between the countries.

The Traffic Advisory Unit (TAU) is a multi-disciplinary group working within the Department for Transport. The TAU seeks to promote the most effective traffic management and parking techniques for the benefit, safety and convenience of all road users.

Department for Transport

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Scottish Executive

Within Scotland enquiries should be made to:
Scottish Executive, Development
Department, Transport Division 3, Zone 2-F,
Victoria Quay, Edinburgh, EH6 6QQ,
Telephone 0131 244 0847
e-mail: roadsafety2@scotland.gsi.gov.uk

Llywodrath Cynulliad Cymru Welsh Assembly Government

Within Wales, enquiries should be made to:
Welsh Assembly Government,
Transport Directorate, 2nd Floor, Cathays Park,
Cardiff, CF10 3NQ
Telephone 02920 826444
e-mail: keith.alexander@wales.gsi.gov.uk



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