Traffic Control System Design for All Purpose Roads (Compendium of Examples)

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First published 2003
Printed and published by the Highways Agency
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December 2003
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Annex A: Glossary
1. INTRODUCTION

General

1.1 This guide has been prepared to assist in the design of schemes involving the control of traffic using traffic signals or the presentation of dynamic information to drivers from the roadside (such as variable message signs). It does not cover in-vehicle information systems or any systems used on motorways. It is intended for use on trunk roads, including All Purpose Trunk Roads.

1.2 This guide has been developed in conjunction with local highway authorities, industry, and the Department for Transport through an action group of the Electrotechnical Industries Traffic Control Advisory Committee (EITAC).

Scope

1.3 The guide is intended to assist designers of traffic control and information systems by presenting examples which illustrate good practice. It is aimed at practitioners already experienced in traffic system design. It is not intended to be a text book or beginners’ guide.

1.4 It should be read in conjunction with the Code of Practice for Traffic Control and Information Systems on All-Purpose Roads (TA 84) which forms part of the Design Manual for Roads and Bridges (DMRB). As well as listing the relevant current published advice guidance and legislation the Code of Practice sets out the procedures for the whole life cycle of traffic control and information systems to ensure a consistent approach and full consideration of safety at all stages in the development of a scheme. The Code of Practice also introduces a System Certification process which can develop formal evidence that the procedures set out in the Code have been followed.

1.5 The examples used in this guide are to be taken as demonstrating how good design has been used in a particular situation. They are not intended to serve as models for general application. Advice on the design of traffic control and information systems can be found in various Departmental publications such as LTNs (Local Transport Notes), TALs (Traffic Advice Leaflets) as well as TAs and TDs (Traffic Advice notes and Traffic Directives) which are published by the Highways Agency and contained in the DMRB. In each topic area the relevant published advice should be consulted before considering the design process. The examples are provided to show how the advice has been successfully applied in particular cases.

1.6 General information on design can also be found in Transport in the Urban Environment published by the Institution for Highways and Transportation.
Implementation

1.7 This guidance should be used forthwith when installing road schemes, including those currently being progressed, unless directed otherwise by the Overseeing Organisation.

1.8 Any comments or enquiries relating to this document should be addressed to:

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2. DESIGN EXAMPLE

Introduction

2.1 This section uses a real world example to illustrate the use of the Code of Practice for Traffic Control and Information Systems TA84/01 (CoP) in developing a design. It must be emphasised that this is only an example of how the CoP has been applied and should not be taken as a model for application of the CoP which is suitable for all traffic control and information systems, nor is it intended to give suggested engineering solutions.

2.2 In the example, the concept to provide traffic signals at an existing priority junction (non trunk) was generated as part of a town centre study undertaken by a consultant for the highway authority. Design work by the authority’s in-house traffic signal design team was then commissioned. This scheme has now reached the completion of the preliminary design stage. The design organisation operates a UKAS registered Quality Assurance scheme as required by the CoP. The QA scheme includes a procedure for recording the competencies of design staff and their supervisors and training needs.

Design Brief

2.3 The scheme designer’s brief was formulated at a meeting of local authority officers with responsibilities for traffic and transportation strategy, public transport provision and planning. The minutes of the meeting were accepted as the formal documentation of the brief.

2.4 The CoP was applied once design resources had been allocated to the task of preliminary design. A design file was opened by the design engineer and the design brief and quality plan placed in it. The quality plan fulfilled the CoP requirement for the provision of evidence of competence of personnel by recording the names of staff with roles within the preliminary design process, and referring to staff competency records held within the quality assurance system.

Hazard List

2.5 Analysis of the scheme requirements and traffic modelling with LINSIG led to the development of two preliminary layout options (Figures 2.1 and 2.2 on pages 2-8 and 2-9). A risk assessment (as required by the CoP) for the preliminary design stage was undertaken by the scheme designer which formed the basis of the Safety Case. An extract from the risk assessment hazard list is given below.

2.6 Hazards addressed by Departmental Standards and Advice notes, or through the specification and approval of items of equipment subject to Statutory Type Approval need not be listed, except when the scheme proposal does not comply with them. For example, certain hazards posed by traffic approaching on Winchester Hill at speeds in excess of 40mph are addressed by TAL 2/03 making it unnecessary to list them, as the requirements of TAL 2/03 are incorporated into the scheme. Alternatively, the recommendations of TA 50 on inter-visibility cannot be accommodated in option 1, and therefore this aspect of the scheme must be considered a hazard to be analysed (hazard no. 3).

2.7 The format of this hazard list has 3 columns containing a brief description of the hazard, any proposed measure to counteract the hazard and a brief assessment of the remaining hazard. For hazard no. 4, which the designer considered warranted a more detailed assessment of the remaining hazard, the assessment is provided in the main body of the Safety Case.

Note: This Risk Assessment Hazard List is given as an example of the method only. It is not intended for use as a model for other schemes.
## Risk Assessment Hazard List

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Countermeasure</th>
<th>Remaining Hazard Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Signal Head / Sign Conspicuity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Buses may obscure nearside signal on Winchester Rd eastbound</td>
<td>provide offside primary, change incorporated in preliminary layout</td>
<td>none</td>
</tr>
<tr>
<td>2. VMS signs on Cupernham Lane (E ftwy) and Winchester Hill (S ftwy). Lit legends and flashing amber close to signal heads could be confusing.</td>
<td>relocate VMS signs and associated over height detectors – position to be determined in detail design</td>
<td>none</td>
</tr>
<tr>
<td><strong>Intervisibility (TD 50/99)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Intervisibility safety standard not met; between Cupernham Lane pedestrian crossing (East footway) and Winchester Rd East stop line (option 1 only)</td>
<td>consider relocating pedestrian crossing closer to junction (Resolved in option 2 by removing ped crossing on Winchester Hill East) cut back overhanging tree canopy</td>
<td>to be considered in detail design if option 1 selected.</td>
</tr>
<tr>
<td><strong>Other Hazards</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Uncontrolled access within junction potentially conflicts with pedestrian stages.</td>
<td>Call all red using loop, before the pedestrian stage inform residents of signal operation.</td>
<td>Refer to safety case discussion.</td>
</tr>
<tr>
<td>5. Vehicles slowing to turn into private accesses may be hit by vehicle in rear.</td>
<td>Provide central hatching and KEEP CLEAR markings</td>
<td>Minimised</td>
</tr>
<tr>
<td>6. Vehicles turning right into Lodge after green terminates are in conflict with Winchester Hill ahead traffic.</td>
<td>Provide locally associated secondary signal – change to be made during detailed design.</td>
<td>Confusion minimised.</td>
</tr>
</tbody>
</table>

### Assessment Example

**Scheme:** A3090 Winchester Hill / Cupernham Lane, Romsey, Options 1 and 2  
**Assessment Date:** 20/8/01  
**Assessed By:** J Mundy

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**Photo 2.1** VMS sign on Cupernham Lane which would obscure primary signal

**Photo 2.2** Driver’s view from Winchester Hill (East) towards Cupernham Lane
Safety Case

2.8 The Safety Case, as defined in the CoP is a logical argument that draws together evidence contained or referenced in the Design File to establish that the scheme has been developed to an acceptable level of safety. As recommended by the CoP, it has been generated before the completion of the preliminary design stage and has been prepared by the scheme designers.

2.9 The Safety Case starts with relevant background details that summarise the scheme objectives and any design policy to be taken into account. This information is helpful to anyone unfamiliar with the scheme, in understanding the arguments put forward.

2.10 The scheme including its boundary are defined at the preliminary design stage by reference to the preliminary layout drawings.

Safety Case for A3090 Winchester Hill / Cupernham Lane – Preliminary Design Stage

Prepared by: J Mundy

Scheme Background

The A3090 Winchester Hill / Cupernham Lane junction is located within the residential area of a small Market Town (Romsey) where a strategy for overcoming peak hour traffic problems has been developed by transportation consultants on behalf of the County Council who are the highway authority. The County Council’s transportation team are client for the scheme. The strategy aims to provide priority access to the town centre for public transport, cycles and pedestrians through a range of measures that includes the introduction of traffic signals at several key junctions on the edge of the town. The client’s policy for all signal controlled junctions is to incorporate pedestrian signals and cycle facilities where feasible and this policy has been applied in the design of the scheme. The signalisation of the existing priority junction at Winchester Road / Cupernham Lane is proposed by the client to provide the opportunity for regulating priority and to make it easier for traffic on the side road to enter the main road flow.

The brief for the scheme was developed at an inception meeting attended by representatives of the client team, district planning and transportation staff and the traffic signal design staff. The minutes of the meeting are contained in ref 1. Preliminary design was undertaken by the County Council’s traffic signals team who have both client and consultant roles within the authority. Safety audits will be undertaken by an independent team within the authority.

Scheme Defining Documentation

Preliminary layout drawings numbered; Option 1 Drawing TS/JAM/619/1(ref 2); Option 2 Drawing TS/JAM/619/2 (ref 3).
2.11 The names, responsibilities and competence of personnel involved in the design of the scheme which are required as part of the Safety Case, are provided in other documentation referenced in the Safety Case.

2.12 Accident history is required to establish the safety Case for the scheme concept.

2.13 Any specific safety objectives of the scheme are to be listed – none in this case.

2.14 The safety argument is the crux of the Safety Case. The first paragraph lists the logical requirements that the argument must satisfy.

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### Personnel

The key personnel involved in the preliminary design are named in the Quality Plan (ref 4) and the qualifications and competence of staff are established under the design organisations QA procedures and are documented in ref 5.

### Accident History

A review of the personal injury accident record for the existing priority junction and approach roads has shown that accident rates are below the mean for priority junctions within the County. Statistics taken from the County’s STATS 19 database for the last 3 years are as follows:

<table>
<thead>
<tr>
<th>Personal Injury Accidents from 1997 to 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
</tr>
<tr>
<td>Serious</td>
</tr>
<tr>
<td>Slight</td>
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<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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There were no specific safety related objectives for the scheme.

### Scheme Safety Argument

The following safety argument is intended to:

- make the case that potential hazards have been reduced to an acceptable level;
- establish that any aspects of the scheme outside the scope of, or not in accordance with, Departmental Advice, Standards, TSRGD or Statutory Type Approval are adequately safe.
- justify the speed related design standard applied to the scheme.
2.15 Potential hazards identified during the risk assessment are listed in the hazard list. Mitigating measures have either been incorporated into the preliminary design drawing or are deferred to the detailed design stage.

2.16 For one hazard the argument is made that the magnitude and severity of the residual risk, after the application of mitigating measures is small enough to be acceptable.

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### Potential Hazards

A single risk assessment for scheme options 1 and 2 was undertaken as the differences between the schemes are minor (ref 6). The option drawings are:

- Option 1 - TS/7/JAM/619/1
- Option 2 – TS/7/JAM/619/2

Of the 6 hazards in the list, 2 have been eliminated or minimised through changes incorporated into the preliminary layout of both options 1 and 2 (nos 1, & 5). Hazard 3 only applies to option 1, and will have to be reconsidered during detailed design of that option. A further 2 hazards (nos 2 & 6) can be resolved, and the changes have been deferred to detailed design.

Mitigating measures are proposed for hazard 4. This hazard concerns the potential conflict between uncontrolled traffic emerging within the junction conflict area, and pedestrians using the signal controlled crossings. The crossings would normally be equipped with tactile facilities for the visually impaired in line with client policy.

The severity of risk is considered to be low, as the alignment of vehicle paths will ensure that vehicle speeds are low. The frequency / magnitude of risk will also be low, as the access serves a private residence. Development plans for the site mean that this arrangement will have a limited life of less than 5 years. Pedestrian volumes are also low.

An alternative proposal considered during design to eliminate this risk was to signalise the private access. It is considered that the dis-benefits of increased delay to other users of the junction, and the high standards of maintenance required for detection would outweigh any safety benefits of such a proposal.

Mitigating measures will reduce the frequency of risk by providing an opportunity for egress from the access through an all red stage appearing before the pedestrian stage. The severity of risk will be reduced by omitting tactile facilities for the visually impaired, until the access is moved under the future development proposal.
2.17 As the CoP states, hazards already covered by regulations, standards and specifications need not be covered by the scheme Safety Case. It is therefore necessary to establish any aspects of the scheme that do not comply and, if necessary make the safety case for those aspects of the scheme.

2.18 Two aspects of the proposed scheme are outside the scope of existing regulations. However, these aspects will be subjected to site specific approvals by the Department, and therefore do not have to be considered further in the Safety Argument.

2.19 Failure to achieve the inter-visibility standard needs only to be addressed if option 1 is selected. This issue is therefore deferred to detailed design.

2.20 Where standards and advice vary according to site specific parameters such as 85%ile speeds, the choice of design standard has to be justified if the safety argument is to be made.

Standards and Approvals

The proposed layouts are in accordance with the Departmental Advice and Standards given for trunk roads and the TSRGD except with regard to the following:

(i) A TOUCAN layout, for which regulations are not yet in force, is proposed on Winchester Hill West;

(ii) inter-visibility is not in accordance with TD 50/99 for Option 1.

Implementation of the scheme will depend on the obtaining of site specific Departmental Approvals for (i) and (ii) which will sought during detailed design.

All equipment proposed is subject to Statutory Type Approval except for selective bus detectors. The Safety Case for these detectors will be added during detailed design.

The inter-visibility non compliance only applies to option 1. A safety argument will be developed if this option is selected for detailed design.

The speed limit on all 3 legs of the junction is 30 mph, but a transition from 30 to 40 mph occurs on Winchester Hill East. A speed survey was undertaken on Winchester Hill East established that the 85%ile speed towards the junction was 42 mph (ref 7). This value was used as the design speed on that approach for setting primary signal visibility distance and speed related green extension requirements in accordance with TA 12/81. A speed of 30 mph was assumed for the other approaches where speeds are regulated by road alignment, width and the speed limit.

References
1. Minutes of Inception Meeting 5. QA Staff Qualifications and Competencies Record
2. Drawing TS/JAM/619/1 6. Risk Assessment Hazard List
3. Drawing TS/JAM/619/2 7. Speed Survey Data
4. Project Quality Plan
Safety Review

2.21 On the completion of preliminary design, a stage 1 safety audit was completed by competent staff independent of the design staff. The scope of the safety audit encompassed a review of the safety of the proposed method of control. At the preliminary design stage a staging plan and outline method of control was available, but there were no equipment specifications. The auditors were given access to the Design File documentation including the Safety Case.

2.22 As would be expected from an independent audit, the Safety Audit Report opposite lists some problems that were not raised in the designer’s risk assessment.

2.23 Problem 2 is related to the stage sequence.

Future Design and Implementation

2.24 Future detailed design will consider the hazards deferred from the preliminary design stage, and will address the problems and recommendations listed during the safety review.

2.25 The designers risk assessment hazard list will be revisited and may be extended as the proposals are modified and the system defined in more detail. The Safety Case will have to be revised.

2.26 During detailed design it may also be necessary to prepare risk assessments for the construction and maintenance for the purposes of the Construction (Design and Management) (CDM) Regulations.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Recommendation</th>
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<tbody>
<tr>
<td>Cyclists eastbound on Winchester Hill entering the shared cycle/pedestrian route on the south footway may collide with pedestrians if travelling at speed.</td>
<td>Consider the segregation of pedestrians and cyclists, and the provision of appropriate tactile surfaces.</td>
</tr>
<tr>
<td>Right turning traffic from Winchester Hill clearing during the inter stage may conflict with pedestrian green across Cupernham Lane.</td>
<td>Change stage sequence so that the pedestrians stage does not follow the right turn movement.</td>
</tr>
<tr>
<td>Tactile paving and push buttons in central refuges may encourage pedestrians to cross to island again a red signal.</td>
<td>Consider removal of Cupernham Lane island. Make option 2 preferred option.</td>
</tr>
<tr>
<td>Forward visibility for westbound traffic is limited by vertical alignment. Drivers could have difficulty stopping behind queuing traffic.</td>
<td>Provide anti-skid surfacing on sections where visibility is limited.</td>
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Figure 2.1 Option 1
Figure 2.2 Option 2

STAGING DIAGRAM

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<tr>
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3. ARROW SIGNALS

Types of signal

3.1 Two types of green arrow signal are currently in use – the earlier 300mm arrow with a solid arrow symbol and the current segmented or “chevron” style arrow which is usually 200mm. The segmented style gives better legibility of the direction of the arrow which allows the smaller size to be used. 300mm signal aspects (except for the signal showing different white symbols for the control of tramcars) are no longer authorised for use at new intersections.

Significance of green arrow signals

3.3 The significance of the green arrow is given in the Traffic Signs Regulations and General Directions (TSRGD) 2002 as:

“the green arrow signal shall indicate that vehicular traffic may, notwithstanding any other indication given by the signals, proceed beyond the stop line only in the direction indicated by the arrow for the purpose of proceeding in that direction through the junction controlled by those signals”.

Use of Green Arrows

3.4 Green arrow signals are used in three distinct ways:

Signalled movements

3.5 Where a three aspect signal head controls a traffic stream comprising only one directional movement, the normal green aspect is replaced by a green arrow indicating the permitted movement. Where more than one movement is permitted, additional arrows may be added but in each case the arrows are illuminated after red/amber and are followed by an amber signal.

3.6 Early versions of the TSRGD did not include the word “only”, implying that although the green arrow allowed movement in the direction of the arrow, other movements were not necessarily prohibited. This led to the use of additional regulatory signs with white-on-blue arrows (diag 606 in TSRGD) mounted alongside the green arrows to enforce the requirement to proceed only in the direction of the arrow. These regulatory signs are not now legally necessary to
enforce the movement. Even so, there are instances where, when the signals are on red, the permitted direction which will be given by the green arrow is not obvious.

Photos 3.2(a)(b) Signalled movement arrows with 606 signs

3.7 In the example shown in Photographs 3.2(a) and (b), the 606 signs give an additional warning to drivers. The signals are on the approach to a crossroads where only the left turn is permitted. In the absence of the 606 signs, drivers may not be aware that other movements are not permitted until the time that the red-amber changes to green arrow.

3.8 In other cases, where different movements share the same stop line, 606 signs cannot be provided and it should be considered at the design stage whether there is a risk of drivers committing themselves to an incorrect movement.

3.9 At this staggered junction (see Photographs 3.3(a) and (b)) the right turn movement runs at a different time from the left turn and “straight ahead” movement (which is a left-right stagger). Drivers were observed turning left when the right turn red-amber appeared. An experimental amber arrow is being tried at this site to eliminate this problem. Amber arrows are not prescribed and a decision on their future use will be made after trials are complete.

Photos 3.3(a)(b) Experimental amber arrow

Filter Arrow

3.10 A filter arrow is an arrow normally mounted alongside the green aspect of a three aspect signal head and illuminated together with the red signal when the permitted movement is allowed by the signals. It is extinguished when the full green aspect is illuminated. It can be used when one movement is permitted to start before the full green. It cannot be used where the movement is required to stop independently of other movements. This will require a double headed signal with two red aspects.

Indicative arrow

3.11 This is an arrow signal, mounted alongside the green aspect of a three aspect signal head, which is illuminated together with the full green aspect. As all movements are permitted by the full green signal, the addition of the arrow does not have any legal significance. By custom and practice it is used to indicate that the
movement indicated is protected in that opposing traffic is being shown a red signal. It is conventionally used in early cut-off staging where it appears during the green period to indicate that the right turn movement is protected.

3.12 The arrow is extinguished at the same time as the full green aspect when the amber signal appears. It has also been used in late release staging in those areas of the country where this form of control is used to indicate the period where the right turn movement is protected. In this application, the arrow appears at the same time as the full green signal and disappears when the protected right turn stage ends. In this case, the loss of priority is less visibly indicated as there is no amber signal following it. Even so, where late release signalling is used, not using an arrow gives no warning at all to right turners of the end of the priority stage. TA16/81 does not recommend the use of late release signalling.

3.13 An indicative arrow has also been used at cross roads layouts where opposing approaches are separately staged. The green arrow is shown at all times with the full green signal and indicates to drivers that opposing traffic is held against a red signal. This can help to reduce the hesitation of drivers of right-turning vehicles, particularly at the beginning of their stage, if they are uncertain whether the opposing straight-ahead traffic is about to start.

3.14 Indicative arrows are normally only installed on the secondary signal heads.

**Interpretation of Green Arrows**

3.15 In designing signal phasings and displays it should be borne in mind that there is a common assumption that a green arrow not only indicates a permitted movement but implies a protected movement. There are possible arrangements where the only permitted movement is not necessarily protected.

3.16 For example, (see Figure 3.1), with this combination of one-way and two-way streets, traffic from the south has to turn right and an arrow signal is appropriate. However, under certain staging arrangements, it may be in conflict with traffic from the north. An arrow signal may be interpreted as a protected right turn movement. A full green signal may be used, with movements other than the right turn prevented by “no left turn” and “no entry” signs. Otherwise, the staging may be arranged so that northbound and southbound traffic do not run together.
Figure 3.1 – An example requiring care in the use of arrow signals
4. ENTRANCES WITHIN JUNCTIONS

Location

4.1 The junction of A49 and Norley Road, Cuddington Cheshire.

Characteristics

4.2 This is a junction between the heavily trafficked A49 with a high proportion of Heavy Goods Vehicles in the centre of the village of Cuddington.

4.3 There are two accesses which enter the junction directly.

White Barn Access

4.4 There is an access from the yard at the rear of the White Barn public house on to Norley Road. The access emerges close to the traffic signals stopline. As it is before the stop line there is no necessity to signal this entrance.

4.5 Traffic emerging from the access and turning left will arrive at the stopline without crossing any of the System D detectors. To avoid the possibility of vehicles becoming trapped at quiet traffic periods, an additional detector is installed at the stopline. This detector will call, but not extend, the Norley Road phase.

4.6 Traffic turning right from the access may cross the Z detector of the Norley Road System D installation. This detector is set (as is common for Z detectors) to extend but not call the Norley Road phase. This prevents the phase being called unnecessarily by vehicles from the White Barn yard turning right, away from the signals. Unidirectional detectors can also be used to avoid this problem.

4.7 The junction has a station access emerging at the south-east corner from Cuddington railway station. The level of traffic emerging is very low, only a handful of vehicles per hour during the day.

4.8 To ensure safety, the entrance has its own exclusive stage in the traffic signal cycle. With low pedestrian flows on the footway across the entrance and good visibility between pedestrians and drivers, pedestrian signals across the entrance have not been used.
4.9 The secondary signal for the station access is located on the near side of the junction. This is because a far side location could give misleading indications to traffic on other phases. Potentially the secondary for Norley Road (which is visible from the station exit) could be confusing to traffic entering the junction from there. This is very much less likely as traffic from the station will be aware of the main junction while traffic on Norley Road may be unaware of a signalled exit from the station. This secondary is angled away from the station exit traffic and is on the left of the driver’s eye line for traffic emerging from the station exit. In situations where there is a real risk of confusion and there is no suitable alternative location, tunnel visors or louvres could be used to limit visibility.

4.10 Conflicts between pedestrians and vehicles also need to be considered in these situations. In this example, there is no segregation between pedestrians and vehicles on this privately owned approach but flows and speeds are low. The designer also needs to assess whether the conflict between emerging vehicles and pedestrians crossing the mouth of an entrance justifies additional signs or signals for pedestrians. This will depend on an assessment of risk in which flows of pedestrians and vehicles, vehicle speeds and visibility between pedestrians and vehicles will be factors.
5. SITING OF SIGNALS

Siting of signal poles

5.1 There are several factors which constrain the siting of signals poles. LTN 1/98 and TAL 1/02 contain relevant advice.

Position

5.2 The signal head must be in the required position. This is more critical in the case of primary signals which are normally installed at a specific distance from the stop line. For other signals, they must be sited where road users will expect to find them, have adequate visibility and not give misleading indications by being visible to those for whom they are not intended.

5.3 Poles must be sited where they are not in danger of being hit by vehicles. This usually implies a minimum horizontal clearance of 450mm from the pole (or overhanging signal heads) to the kerb edge. This is a particular problem with pedestrian signal heads which are directed across the carriageway and therefore have a larger overhang towards the kerb than vehicle signal heads. Additional clearance may be required where there is a severe crossfall or camber, on sharp

Photos 5.1(a)(b) This pedestrian head with insufficient running clearance has been damaged by a passing vehicle

Photo 5.2 Pedestrian signal in the centre of the footway
(Note – no tactile paving has been installed at this crossing)
corners (where long wheelbase vehicles or trailers may overhang the
carriageway, or where mounted in the central reservation of a dual carriageway.

Obstruction

5.4 Poles should not obstruct the footway or entrances. Keeping poles back
from the kerb edge to increase clearance can cause obstruction to narrow
footways making difficulties especially for push chairs and wheelchairs.

Photos 5.3(a)(b) Cranked poles used to avoid obstruction
(Note: layout of tactile paving is not to design recommended in “Guidance on the
use of Tactile Paving Surfaces”)

5.5 Cranked poles can be used to offset the signal head and reduce the
obstruction. On very narrow footways a cranked pole at the back of the footway

minimises the obstruction. The disadvantage of this arrangement is that the
pushbutton is mounted behind the place where the pedestrian waits to cross.

5.6 Cranked poles may not always provide an acceptable solution because of
aesthetic considerations. Designers should consult with other sections/
departments of the Highway Authority with a special interest in the street scene
to reach an agreed local compromise. Problems have been experienced with
welded cranked poles. Internal rusting can occur at the welds and the sharp
edges can damage insulation when cables are installed.

5.7 Cranked poles and other poles with offset mountings (such as extended
brackets) require careful installation as they will tend to lean if the root is not
firmly supported.
5.8 Puffin crossings use nearside pedestrian indicators and so do not require pedestrian signal heads. This reduces the overhang from the pole towards the carriageway. In this example, the pole has been rotated through 45° so that the signal head bracket mounting holes align at an angle to the carriageway. The heads can then be mounted with the centre line of the signal head offset from the centre line of the pole and the overhang of the signal head can be eliminated. This enables a signal to be erected close to the edge of the footway without the need for a cranked pole.

5.9 Difficult sites may need unique solutions. An extended cranked pole has been used here (Photograph 5.5) to locate a signal head in the correct position alongside an elevated carriageway. In this installation the lamp transformers are mounted in the base of the pedestal for ease of maintenance. Terminations must be made in a suitable housing, which is waterproof and takes into account the problem of condensation.
6. PHASING AND STAGING FOR TRAFFIC SIGNAL CONTROL

Introduction

6.1 This section should be read in conjunction with TA15 (Pedestrian Facilities at Traffic Signal Installations) and TA16 (General Principles for Control by Traffic Signals) which give general advice on signals design.

6.2 The analysis of a traffic signal junction to provide details of optimum timings and predicted performance in terms of capacities, delays and queues is best performed by the use of specialist software packages such as OSCADY or LINSIG. These packages require the user to input not only the geometrical details of the junction and traffic flow information but also the proposed control method in terms of phasing and staging. Although it is possible to submit a wide range of staging arrangements for individual analysis by the software, there are substantial advantages in carrying out a preliminary assessment to identify the preferred staging or a limited number of staging arrangements for detailed analysis. The preliminary analysis will give a general indication of whether the junction would operate comfortably or close to its capacity limit. This is very valuable in interpreting the output from the software packages and identifying any unrealistic results which would indicate errors in the input data.

Preliminary Assessment

6.3 A preliminary assessment can be carried out using the basic concepts of the analysis developed by Webster and Cobbe. This is based on the assessment of the critical “y value” of each stage in the cycle where “y value” is defined as the ratio of the demand to the saturation flow – in other words, the proportion of time a signal has to be green to allow the demand flow to pass. A flow of 1000 pcu/h crossing a stop line with capacity 2000 pcu/h needs a signal which is green for at least 50% of the time, a y value of 0.5.

6.4 Clearly, if the y values for all the stages in the cycle are summed and their total (given the symbol “Y”) is >1 then the junction has insufficient capacity whatever timings are applied. In practice, because there is lost time at stage changes and it is not practical to operate any traffic system at 100% of its theoretical maximum capacity, values of Y much greater than 0.8 indicate potential capacity problems.

6.5 Note that the actual maximum practical value of Y (Y_pract) depends on the number of stages and the length of the intergreens and can be calculated using the full Webster and Cobbe method but broad approximations are sufficient for preliminary assessment where the detailed analysis is to be undertaken using OSCADY or LINSIG. The value of 0.8 a rough estimate of Y_pract based on a simple junction with typical intergreens.

Overall Capacity

6.6 Before investigating any special staging requirements it is worth checking that the main traffic flows do not exceed the overall capacity potential of the junction. A simple junction will require two stages. However lightly trafficked, it must be assumed that the minor stage will run for at least the minimum green time in each cycle. This will mean assigning it a y value of at least 0.1 (7 seconds out of a typical 70 seconds cycle time). The y value for the main stage needs to be assessed using a realistic assessment of the saturation flow (remembering that one lane on an approach may potentially be blocked by vehicles waiting to turn right.

Right turning

6.7 The critical movements in determining a staging arrangement for a junction are usually the right turning movements. The first task in drawing up a preferred
staging arrangement or a short list of possible arrangements is to assess the need for additional stages to accommodate right turning traffic.

6.8 Vehicles waiting to turn right beyond the stop line will complete their movement in the intergreen period. A typical junction will have space for two or three vehicles which means that between 100 and 150 vehicles will be able to turn right in an hour with a typical cycle time of 70 seconds. (Note that as cycle time increases, although overall capacity increases as the lost time at stage changes decreases as a proportion of cycle time, this “free” right turn capacity decreases as the number of cycles per hour decreases.)

6.9 The actual number of vehicles able to turn right in an hour may in practice be higher than this as some will turn in gaps in the opposing flow but this calculation sets a lower limit below which a right turning stage is not likely to be required. A little above this may or may not justify a separate stage and OSCADY or LINSIG can be used to analyse the alternatives. Much higher right turning flows (above 200 pcu/h) are likely to require a special stage.

6.10 An important factor is whether right turners waiting to turn right interfere with straight ahead traffic. If right turners potentially block a lane it will be necessary to assess the straight ahead traffic as using only the remaining lane or lanes. For single lane approaches it may be necessary to allocate a stage for that approach alone so that straight ahead and right turning traffic can always flow together.

Types of right turning stage.

6.11 Designing for right turning traffic is dealt with in Section 10 of this guide. Please refer to that section for more details of the staging arrangements referred to in this section.

6.12 For the purpose of this preliminary assessment, it is not necessary to distinguish between an overlap stage (e.g. early cut-off) and a similar arrangement where the right turn is separately signalled. As, for the approximation of this type of analysis traffic turning through gaps is ignored, both types of staging have essentially the same capacity. The choice is between an overlap arrangement (whether or not the right turn is separately signalled), an arrangement where both right turning movements are signalled at the same time and separate stages for each of the opposing arms. It is possible to have different staging or stage order for different times of the day but care must be taken to avoid confusion to drivers if stages appear in an unexpected manner.

6.13 The choice between these alternatives depends on the balance of flows. If the right turning movements from opposing directions are both large enough to justify a right turning stage and they are comparable in volume then a staging with concurrent right turning movements may be appropriate. If they are very different, separate staging for the opposing approached may be appropriate. With a stage allocated to one approach there is no need to reserve a lane for right turning traffic and the capacity for straight ahead traffic will be increased. This has to be balanced against the loss in capacity because opposing straight ahead traffic streams do not run together.

6.14 With early cut-off signalling (or its separately signalled equivalent), one straight ahead movement has more green time (because it runs in two stages) than the opposing straight ahead movement. If this is roughly equivalent to the balance of straight ahead flows then this arrangement is likely to be efficient.

Pedestrian and cycle facilities

6.15 The staging arrangement for a junction will have implications for how pedestrian and cycle facilities can be provided. (See Sections 7 and 9 of this guide). If an exclusive pedestrian stage is required, this will typically require 20 seconds of the cycle time. In order to accommodate this, cycle times are likely to be rather longer but even so the pedestrian stage will represent a y value of 0.2 to 0.25. This preliminary analysis will indicate whether an exclusive pedestrian stage is feasible while maintaining sufficient capacity to handle vehicular demand. Longer cycle times will also increase waiting times for pedestrians and delay to vehicles. If an exclusive pedestrian stage is not appropriate, the staging
and layout of the junction will require to be planned to provide walk with traffic pedestrian facilities where required. This will then define the staging arrangements which are submitted to the more detailed analysis.

**Summary**

6.16 The preliminary analysis is not intended to produce a definitive staging arrangement for a junction. It is helpful in ruling out at an early stage in the design process ideas which will not produce practicable solutions. It can indicate situations where traffic signals are not appropriate or suggest that carriageway widening may be necessary to obtain the required capacity.

6.17 Detailed analysis will require more accurate estimates of saturation flow, clearances and intergreen times. Since the preliminary analysis is approximate, any conclusions about the suitability of certain arrangements which are marginal should be tested by detailed analysis.

6.18 The essential aspect of the preliminary analysis is that it is a quick review. In many simple cases the process set out here can be carried out by an experienced engineer almost by inspection although it is an important part of the design process that any decisions made as a result of this preliminary analysis should be recorded and backed up by notes along the lines of the worked example given here.

**Worked example**

6.19 Given the layout of the junction and traffic flows.

i) Estimate the “free” right turning capacity of each approach

ii) Identify the right turning movements which exceed the “free” capacity

iii) Identify the separate traffic streams and estimate saturation flows for them

iv) Calculate y values for each traffic stream

v) Test different staging arrangements for minimum Y

vi) Consider pedestrian requirements and amend staging proposals if necessary

vii) Determine which arrangements should be subject to detailed analysis

6.20 The example relates to a four way junction with two lane approaches on the main road and single lane approaches on the side road. There is storage space for two right turning vehicles from the main road in each direction and one right turning vehicle from the side road.

6.21 With the flows given, there is sufficient “free” right turning capacity to clear the demand in the intergreen for all right turning movements except the movement from the south to the east.

6.22 Saturation flows may be assessed using the method set out in TRL Report RR67 (The prediction of saturation flows for road junctions controlled by traffic signals). For the purpose of this preliminary analysis a typical value for the area may be used. The values used should be selected to suit local conditions but should err on the low side. In this case saturation flows have been assumed as 1900 pcu/lane for straight ahead flows and 1650 for turning flows. Lanes with mixed movements have been interpolated between these.

*First assessment (Using an early cut-off arrangement).*

6.23 Y is estimated at 0.60. (Note, at this level of approximation there is little point in calculating y values to more than two significant figures).

6.24 This result indicates that this arrangement is likely to be practicable. If an exclusive pedestrian stage is added to the cycle, Y will rise to 0.80 or more making the practicability more marginal. This would need to be tested by detailed analysis.

*Second assessment (Using separate staging for each direction on the main road)*
6.25 Y is estimated as 0.70. This arrangement is also likely to be practicable and would allow staggered pedestrian facilities across the main road on each side of the junction. This arrangement would need wider and longer refuges on the main road with extensive guard railing. This staging does not allow for protected pedestrian facilities across the side roads. The staggered movements across the main road would be less convenient for pedestrians than the exclusive stage with straight across movements but the cycle time would be shorter and average pedestrian waiting time would be reduced. There would be more spare capacity than the early cut-off plus exclusive pedestrian stage arrangement but costs and visual impact would be higher.

6.26 This analysis is not intended to be exhaustive. Other staging arrangements are possible. A staggered pedestrian crossing arrangement could be introduced with an exclusive pedestrian stage. This would allow pedestrian clearance times to be reduced as it would only be necessary to allow for pedestrian clearance across half of the carriageway. This sort of variation would be applied at the detailed analysis stage if capacity is critical.

### Assessment 1 – Early Cut-off Staging

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<th>Critical y?</th>
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<td>1800</td>
<td>3</td>
<td>0.08</td>
<td>-</td>
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<tr>
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<td>1800</td>
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### Assessment 2 – Separate staging for opposing main road approaches

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7. DESIGNING FOR PEDESTRIANS

Introduction

7.1 Advice on pedestrian facilities may be found in:

- TA15  Pedestrian Facilities at Traffic Signal Installations
- TA16  General Principles of Control by Traffic Signals
- TD50  The Geometrical Layout of Signal Controlled Junctions and Signalised Roundabouts
- LTN1/95 The Assessment of Pedestrian Crossings
- LTN2/95 The Design of Pedestrian Crossings
- TAL 4/91 Audible and Tactile Signals at Pelican Crossings
- TAL 5/91 Audible and Tactile Signals at Signal Controlled Junctions
- TAL 10/93 “Toucan” an unsegregated crossing for pedestrians and cyclists
- TAL 4/98 Toucan Crossing Developments
- TAL 16/99 The use of Above Ground Vehicle Detectors
- TAL 1/01 Puffin Pedestrian Crossing
- TAL 1/02 The installation of Puffin Pedestrian Crossings

7.2 This section provides illustrated examples of how this advice has been interpreted and applied in practice. It is not intended to be a comprehensive guide to the design of pedestrian facilities.

Visors

7.3 The example (Photograph 7.1) shows a Pelican crossing. The head pointing to the right is a secondary head but has a primary visor. This is appropriate in this case as it needs to be visible at an oblique angle to drivers in the left hand lane at the stop line. (Photograph 7.2) Signal heads can be angled towards drivers at the stop line but not to such an extent that the visibility of the signal to approaching traffic is impaired. At junctions, secondary visors are used to prevent cross traffic seeing what might be a confusing signal. This problem does not occur at pedestrian crossings. The only function of a secondary visor in this situation would be to prevent pedestrians seeing the vehicle signals while waiting to cross. Pedestrians

Photo 7.1 Secondary head with primary visor
are unlikely to confuse the vehicle and pedestrian signals but obscuring them by using secondary visors may reduce the incidence of pedestrians anticipating the pedestrian green when the vehicle signals change to amber and then red.

**Staggered crossings**

7.4 Pelican crossings with a central reserve are usually staggered to avoid problems during the flashing amber/flashing green period. A divided straight-across Pelican acts as a single crossing (unlike a divided Zebra which is legally two separate crossings). Drivers are required to give way to pedestrians on either half of a divided straight-across Pelican but in practice some drivers will proceed when their half of the crossing is clear of pedestrians. With Puffin crossings, there is no flashing amber period and drivers are held on red until pedestrians are clear. Consequently Puffins may be safely installed with a central island without a stagger.

7.5 Staggered crossings give more flexibility in staging and reduce the clearance time for pedestrians resulting in potential improvements in the efficiency (and therefore the capacity) of the junction. They do, however require more street furniture and guard railing which can result in a cluttered appearance. Careful design can reduce the impact of the guard railing.

7.6 The example in Photograph 7.3 shows use of guard railing, dropped kerbs and textured paving. Note the use of push buttons on the central refuge so that demands can be inserted for each half of the crossing separately and there is no chance of a pedestrian becoming “trapped” in the centre of the road.

**Offset crossings**

7.7 An offset crossing is a staggered crossing where the crossing on the exit of the junction has its own stop line. This allows a pedestrian facility across a wide road without loss of capacity. Design of the layout and staging needs careful handling to avoid problems where the junction stop line is closely followed by the signals for the offset crossing. The main risk is that if the signals at the crossing turn green while the preceding signals are still red drivers may interpret the green as giving them right of way and cross the signals at red.
7.8 In the example in Photographs 7.4 and 7.5, this “see through” problem is handled by the use of vertical louvres on the offset crossing signals as recommended in TA15. Louvres are installed on both the green and amber aspects so that drivers waiting at the preceding signals for the main junction do not see the red amber combination which often triggers movements.

7.9 The louvred heads are angled slightly so they can be seen by turning traffic and are also fully visible to drivers close to the signals or waiting at the stop line.

7.10 Horizontal louvres are also commonly used in this application. Horizontal louvres reduce the distance from which they can be seen by angling downwards and are less likely to become visible at greater distances if knocked than are vertically louvred signals. Horizontal louvred signals however cannot be arranged to be visible to turning traffic at a distance. With all louvred signals, particular care should be taken with the alignment and maintenance to ensure that the signal remains effective.

**Exclusive pedestrian stages**

7.11 This urban centre example (Photograph 7.6) has high pedestrian flows and relatively light vehicular flows. An exclusive pedestrian stage is appropriate in this case and provides a good facility for pedestrians while maintaining a...
relatively short cycle time. Because all pedestrian movements occur together it is possible to provide an audible signal which is appreciated by many pedestrians.

Visibility of Pedestrians

7.12 In designing traffic signals, it is important to consider the visibility of pedestrians not only at the formal crossing points but also at informal crossing points if these are used. In this case (Photograph 7.7), although the pedestrian is masked by the oversize bollard, because of the width of the island the pedestrian is not able to step into the carriageway directly from the masked position. If the island were narrower, there could be a serious safety risk particularly because of the right hand sweep of the road which tends to increase the masking potential. (Note also that the edge marking for the marking to Diagram 1040 should lead drivers clear of the island kerbing, not to it, as in the photograph).

Photo 7.7 Oversize bollard masking pedestrian
8. DESIGNING FOR DISABLED ROAD USERS

Introduction

8.1 General advice on providing for disabled road users when designing traffic control and information systems can be found in the following documents:

TAL 4/91: Audible and Tactile Signals at Pelican Crossings
TAL 5/91: Audible and Tactile Signals at Signal Controlled Junctions
LTN 2/95: The Design of Pedestrian Crossings
Guidance on the Use of Tactile Paving Surfaces (DETR 1998)

Siting of Pedestrian Pushbuttons

8.2 The first example (Photograph 8.1) shows a poor location for a pedestrian pushbutton. The pedestrian has to face away from the traffic to operate it and to move some distance from the crossing point. It would be difficult for a visually impaired pedestrian to find and very inaccessible to a wheelchair user.

8.3 The problem stems from the central island being too narrow to accommodate two rows of guard railing with sufficient clearance between them for pushchairs and wheelchairs and the difficulty of siting signal poles with sufficient clearance from the running lanes that do not impede the passage of pedestrians. This has resulted in the primary signal pole (and with it the stop line) being installed some distance from the crossing point.

8.4 Puffin crossings can be used without a stagger and may be appropriate at many sites. This not only results in a more direct crossing path but may obviate the need for guardrailing on the central reserve.
8.5 This example shows a Puffin crossing with a well-located pushbutton. The combined pedestrian indicator and demand unit is angled at 25°-30°, which is convenient for pedestrians and reduces the brightness of the indicator to oncoming vehicles. The pole is located at the recommended distance from the tactile paving which aligns correctly with the dropped kerb.

8.6 The right-left stagger is the convenient orientation for this crossing to a triangular island at a T junction (Photograph 8.3). The crossings have the Puffin characteristics of near side indicators and on-crossing pedestrian detectors but no zigzag markings are used as the crossings form part of a signalised junction. Again the location of the pushbuttons, the tactile paving and the dropped kerbs are optimised for the use of disabled pedestrians although to meet the needs of pedestrians with a visual impairment, accompanied by a guide dog, there should be a push button to the right of the crossing place. This would mean an additional push button on each of the central reservation crossing places. Commonly these are on short posts.

Photo 8.2 Well-located pushbutton

Photo 8.3 Staggered Crossings
9. DESIGNING FOR CYCLISTS

9.1 The following Traffic Advisory Leaflets published by DTLR give advice and information on designing cycle facilities at traffic signals:

- TAL08/93: Advanced Stop Lines for Cyclists
- TAL10/93: “Toucan” – An Unsegregated Crossing for Pedestrians and Cyclists
- TAL05/96: Further Development of Advanced Stop Lines
- TAL04/98: Toucan Crossing Development

9.2 A Toucan crossing provides a facility for both pedestrians and cyclists to cross a road. Toucans are designed for cyclists to ride across rather than dismount and cross as pedestrians, as is the case with Zebra, Pelican and Puffin pedestrian crossings.

9.3 The routes to and from a Toucan crossing need to be continuous routes which cyclists can ride along. In this example (Photograph 9.1), there are segregated cycle tracks on both approaches. The cycle tracks on the approaches to a Toucan should be shared use which pedestrians can also use. Note the use of anti-skid surfaces on the vehicle approaches to increase safety.

9.4 In the next example (Photograph 9.2), part of a footway has been made into a segregated cycle track on the approach to a traffic signal junction with a dedicated cycle phase. The provision of cycle tracks not only encourages the use of a cycle route but contributes to safety by segregating pedestrians and cyclists and alerting pedestrians to the possible presence of bicycles. Care should be taken when using the marking to diagram 1057 that it does not give the impression that the shared route is for cycles only. A smaller size marking is available.
Photo 9.3  Staggered Toucan crossing on dual carriageway
(Note that cycle lanes must start with a marking to diagram 1009.)

Photo 9.4  Toucan head (with on-crossing detector)
(Note that nearside cycle indicators are also available as an alternative to the far-side toucan head shown)

Cycle Lanes and Advanced Stop Lines

9.5 Cycle lanes and advanced stop lines can allow cyclist to reach the front of the queue and move across, where necessary, to take up a position for right turning or straight ahead movements. With an advanced stop line it is essential to provide a cycle lane on the approach.

Photo 9.5  Cycle lane for straight ahead traffic with advanced stop line

9.6 The advisory cycle lane here (Photograph 9.5) is for the major movement which is straight ahead where the cycle lane continues beyond the junction. It is placed between the straight ahead and left turning vehicle lanes. This gives drivers a clear indication of the path of a cyclist moving from the kerb edge to the straight ahead lane. The use of coloured surfacing (red is also used) aids compliance. The advanced stop line enables right turning cyclists to move across to the right hand lane in front of waiting vehicles. (Note that the advanced stop line extends to the nearside kerb. This allows left turning cyclists to make use of the facility and also avoids having a staggered stop line which is undesirable).
9.7 This advisory cycle lane (Photograph 9.6) continues between two signalled junctions. Although only advisory (discontinuous white line marking) it clearly affects the line taken by drivers and allows space for the cyclist.

9.8 This left turning cycle lane (Photograph 9.7) links to a further (advisory) cycle lane around the corner. No advanced stop line is provided here in the left turn lane, as there is no requirement for cyclists to move across to the right, but advanced stop lines are commonly used in this situation to allow the cyclist into a more dominant position in front of, rather than alongside, waiting vehicles. Note that there should be a plain bollard on the third island.
10. DESIGNING FOR PUBLIC TRANSPORT PRIORITY

General

10.1 A good general source document for bus priority is LTN 1/97 Keeping Buses Moving. The examples discussed in this chapter are based on loop detection including Selective Vehicle Detection (SVD) for buses.

Bus Gates

10.2 Bus gates are traffic signals often provided within bus priority schemes to assist buses and other permitted traffic when leaving a bus lane to enter or cross the general flow of traffic or to meter the flow of general traffic as it enters the road link downstream of the bus lane. Depending on their purpose, bus gates can be located remote from other signals or they can be positioned immediately upstream of a signal controlled junction, as a bus pre-signal.

Physical Layout

10.3 Bus gates are normally formed by providing an island between the bus lane and parallel general traffic lanes, and installing stop lines across them. A typical layout of an isolated bus gate is shown in photograph 10.1 (site 1). This particular bus gate is provided to assist buses after leaving a nearside stop, when entering an offside bus lane and to meter general traffic flow during the am peak. The traffic signal aspects for the bus lane are identical to those shown for general traffic but the signal phasing for the bus lane is normally not the same as the general traffic phasing. Consequently, the physical layout and arrangement of

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Photo 10.1 View of example bus lane (site 1)

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signal heads needs to minimise any potential for confusion. This has been achieved in the example by the use of coloured surfacing on the bus lane, and the
staggering of stop lines placing the bus stop line in advance of the general traffic stop line, to differentiate the two separately signalled traffic streams.

10.4 The signal head located on the splitter island, applying to the bus lane is angled acutely towards the bus lane which means that general traffic approaching their stop line have a limited view of the bus lane aspects. Long signal hoods can be used for the same purpose.

10.5 Bus gate traffic signals can be confusing for pedestrians tempted to cross in front of the stop lines. For this reason, pedestrian guard railing has been provided at site 1 to discourage pedestrians from crossing onto the island. Alternatively, the bus gate can take the form of a staggered pedestrian crossing whose layout makes it clear that the bus lane and general traffic lanes are separately phased. An example of this layout is shown in Photograph 10.3).

10.6 At staggered pedestrian crossings where the island separates traffic streams travelling in the same direction, as at site 2, pedestrians may mistakenly assume the normal layout in which the two traffic streams are travelling in opposite directions. Pedestrians may need to be guided by road signs or markings to look towards the oncoming traffic before stepping off the island.

Photo 10.2 Long signal hoods at a bus gate

Photo 10.3 Combined bus gate and pedestrian crossing (site 2)
Method of Operation

10.7 Currently the most commonly adopted method of staging for a bus gate is to provide green for the bus lane and the general traffic lanes in separate stages as shown below. This staging is appropriate when the bus lane traffic has to merge with or cross the general traffic stream downstream of the signals.

![Fig. 10.2 Bus Gate Staging](image)

10.8 Other arrangements are possible where the bus lane and general traffic do not interact downstream allowing green to be shown simultaneously on both the bus lane and the traffic lanes.

10.9 The bus lane green (stage 2) is normally called by a detector in the bus lane. Where it can be assumed that only buses will be present, normal vehicle detectors may be used. If it is necessary to identify buses in a mixed traffic stream Selective Vehicle Detection (SVD) will be required. When cycles are permitted to use the bus lane, a dedicated loop may be needed to ensure that the cycles are reliably detected and call the bus green.

10.10 It may be feasible for the bus lane detector to initiate a change of the signals immediately (subject to controller safety timings) in favour of the bus. This method of operation gives rise to bus delays close to zero. Such an immediate change is only likely to be feasible for low bus frequencies when there is sufficient spare capacity available in the general traffic lane.

10.11 For site 1 referred to earlier, it is necessary to restrict the operation of stage 2 during peak periods in order to maintain an adequate throughput of general traffic, and this means that most buses have to wait at the bus gate. Without this restriction, the general traffic queue would extend beyond the start of the bus lane, thereby delaying buses as well as general traffic.

10.12 The short wait for buses at the bus gate is tolerable in the peak periods because the delay is short compared with the advantage gained by the bus overtaking traffic queuing next to the bus lane, before it reaches the gate.

10.13 Off peak, the bus gate at site 1 provides an immediate response for all buses. There are many other sites where it is necessary to restrict the operation of the bus lane stage both during the peaks and in the off peak. The off peak restriction is normally needed where the bus gate is acting as a pre-signal for a traffic controlled intersection and it is necessary to co-ordinate stage changes at the bus gate with changes at the main junction. Having buses wait for green at the bus gate is less acceptable in off peak conditions because other delay saving advantages of the bus lane and bus gate are less than for the peaks, and may be non existent. If the bus lane / bus gate combination delays buses noticeably during the off peak, bus drivers soon learn when it is advantageous to join the general traffic lane.

10.14 A solution to be implemented at site 1, which may be transferable to some sites, is to change the level of priority granted to buses dynamically using queue detectors. This solution is illustrated in Figure 10.3

10.15 Buses will receive high priority ("immediate" response) unless the queue detector senses the presence of a queue. When there is a queue present, the change in favour of the bus will be delayed to reduce the impact on capacity for general traffic.
Bus Stop Locations

10.16 The location of bus stops in relation to traffic signals and bus gates has a direct impact on the effectiveness of active priority measures. Because the dwell time at a bus stop is unpredictable, it is usual to locate the bus detector used to activate priority after any bus stop on the approach link. The photograph opposite shows an example of a bus stop in close proximity to the stop line of a bus gate (site 3). The time between the detection of the bus and its arrival at signals is short, giving little time for the signals to react and limiting the benefits which can be achieved through active priority in the operation of the signals.

10.17 At sites where there is some flexibility in the location of bus stops, a position after the signals gives significantly greater potential for priority than a position a short way upstream of the stop line.
11. DESIGNING FOR RIGHT TURNERS

Introduction

11.1 This section should be read in conjunction with the relevant advice notes and directives included in the Design Manual for Roads and Bridges including:

TA 16/81 General Principles of Control by Traffic Signals
TAL 2/03 Signal-control at Junctions on High Speed Roads
TD 50/99 The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts.

11.2 These documents contain the definitive advice on signals design. The purpose of this chapter is to give explanation and examples of how this advice has been applied in practice.

11.3 It is also necessary to be aware of the Traffic Signs Regulations and General Directions, which set out the legal basis for traffic signals, define the meanings of signs and signals and specify the permitted arrangements of signals.

Early Cut-Off

11.4 Example 1 (Photograph 11.1) is of an early cut-off facility at a three way intersection. Stage 1 allows traffic on the main road to flow in both directions. In Stage 2, (shown in the photograph) one direction of the main road is held on red allowing a protected turn for right turners into the side road. Stage 3 allows the side road traffic to enter the junction.

11.5 If traffic flows are light, traffic can turn right in gaps in opposing flow. Even when opposing traffic is continuous, vehicles waiting in the junction to turn right can complete their turn during the intergreen. In this case, two vehicles can wait beyond the stopline and turn in the intergreen. Consequently, Stage 2 is not required unless there are three or more vehicles waiting to turn at the end of Stage 1.

11.6 In order to make the appearance of Stage 2 demand dependent, a detector has been installed which straddles the stop line to detect the presence of a third vehicle.

11.7 This detector is configured as a call/cancel detector. The controller does not record a demand from the detector until it is established that a stationary vehicle is present. This is achieved by activating a demand when a presence indication has been received continuously for a predetermined period (typically 2-4 seconds depending on the speed of vehicles in queuing conditions) The demand is cancelled if the loop subsequently becomes unoccupied for a similar continuous period.
11.9 Where early cut-off staging is used at a four-way junction, drivers making the right turn manoeuvre opposite to the one having the right turn facility may need to make their turn during the intergreen. In this case, observing the secondary signal could be misleading. Drivers will observe the secondary signal and, when amber appears, look for the opposing traffic to stop allowing them to turn in the intergreen period. Where opposing traffic has a the advantage of an early cut-off stage, the secondary signal changing to amber and then red does not indicate that opposing straight ahead traffic is going to stop because the opposing green continues into the following stage.

11.10 To avoid this potentially dangerous confusion, the advice contained in TA 16/81 is to locate the secondary signal where drivers waiting within the junction cannot see it. This usually means it being located on the near side (rather than the far side) of the junction, a few metres beyond the primary signal (where it can be seen by drivers of vehicles waiting at the stop line). This is termed a “closely associated” secondary signal. (See Photograph 11.3).

11.12 A similar potential confusion can exist for pedestrians. TD 50/99 encourages the provisions of signal-controlled pedestrian facilities where there is a need and such provision will clearly help. However, pedestrians may still be confused by streams of vehicles, on the same road, moving at different times. The signal and/or physical layout should be looked at to minimise the chance of pedestrians seeing potentially confusing signals. The use of closely associated secondary signals, even at three arm junctions where there is no opposing right turn movement, will often help.
11.13 Photograph 11.3 shows a four way junction with an early cut-off facility for right turners. A “four-in-line” signal with green arrow below the full green is used to give adequate horizontal clearance on a narrow island.

11.14 In the direction opposite to the right turn having the benefit of the early cut-off, a closely associated secondary signal is used. Note that the driver of the car waiting to turn right (Photograph 11.4) cannot see the secondary signal which has turned red although on-coming traffic still has green during the right turn priority stage. The right turning driver must judge when it is safe to turn without making any assumption based on the state of the secondary signal.

Late start

11.15 Late start signalling (also termed “early start” or “late release”) is an alternative form of overlap staging where the protected right turn stage appears before the two-directional main road stage. Although there are several advantages with this form of staging, the problem is the effective signalling of the transition between the right turn priority stage (Stage 1) and the two-directional main road stage (Stage 2). Without a right turn indicative arrow to indicate the protected movement, right turning traffic may hesitate at the beginning of Stage 1 before realising they have priority, resulting in inefficiency of operation. At the end of Stage 1, there can be difficulty due to drivers continuing to make the right turn after opposing traffic has received a full green indication. For this reason TA16/81 does not recommend the use of late start signalling and its use is
currently confined to certain regions of the UK, notably the North West of England and parts of the North East where it is a well established and accepted technique.

11.16 Where late start staging is used, an indicative green arrow is often used to indicate priority. The arrow disappears at the end of the stage as the priority ends, but this indication is much less positive than the end of an early cut-off stage where the green arrow period is terminated along with the full green signal by an amber signal.

11.17 With late start staging, the right turn priority stage is not demand dependent. This is to avoid drivers wishing to turn right anticipating the priority when the stage does not appear. The late start is often used without an exclusive right turning lane. In these cases it is not appropriate to extend the right turn priority stage with detectors.

Separate staging.

11.18 Example 3 (Photographs 11.5 and 11.6) is a junction on a suburban dual carriageway with a 40mph speed limit. Where right turning facilities are required on high-speed roads (85th percentile speed greater than 35mph) these should be separate stages. This is safer than early cut-off staging as eliminates righter turners crossing in gaps in opposing traffic. At other sites, right turning across three or more lanes of opposing traffic is a known accident risk and separate staging should be considered.

11.19 In this example, the right turn stage appears before the two-directional main road stage but these stages could be reversed. This flexibility can be helpful in the design of linked systems but, once designed, the stage order should remain fixed.

11.20 The right turn has its own exclusive lane (which is essential for this type of staging) but there is insufficient carriageway width to make it possible to use a physical separation between the right turning and straight ahead lanes. The right hand primary controls the right turn movement while the left hand primary controls the straight ahead and left turn movements. Both displays are duplicated on the same secondary pole.
11.21 Photograph 11.5 shows the signals in Stage 1. The right turn is signalled green and the opposing straight ahead traffic is held on red. Photograph 11.6 shows the end of Stage 1. The right turn movement is losing right of way while the straight ahead and left turn movements continue on green.

![Photo 11.6 Example 3: End of Stage 1)](image)

(Current regulations require a continuous line for edge of carriageway marking)

**Concurrent right turning movements**

11.22 Example 4 (Photograph 11.7 and Figure 11.4) shows a junction where both right turning movements justify a protected stage and they are relatively balanced. Both right turn movements are arranged to run together in a separate stage. It is, of course, essential to ensure that the junction layout allows the opposing right turning movements to flow without any mutual interference.

11.23 The width available allows a physical separation between the straight ahead and right turning lanes. A double headed signal is used on the separating island so that both the straight ahead and right turning movements have primary signals at each end of their respective stop lines.

11.24 If there was insufficient width for exclusive right turning lanes or the right turning movements were unbalanced, it would have been necessary to provide a separate stage for each direction on the main road. (Example 4 shows a pedestrian crossing point with studs but no pedestrian signals. Note that TD50/99 recommends that signal controlled pedestrian facilities should be provided wherever possible).
11.25 At this T junction (Photograph 11.8) there is a high proportion of right turners from an approach with restricted width. A right turn overlap phase is used, but there is a potential problem of vehicles waiting to turn right blocking straight-ahead vehicles. Setting back the stop line, enlarging the bell-mouth and local widening on the opposing approach has allowed a space for right turners to wait to be provided.
12. DESIGNING FOR HIGH-SPEED ROADS

Introduction

12.1 Advice on designing signals on high-speed roads is given in TAL 2/03: Signal-control at Junctions on High Speed Roads (DMRB Vol 8)

12.2 High speed roads are defined as roads where 85th percentile approach speeds exceed 35mph.

Visibility

12.3 Where approach speeds are high it is essential that drivers have sufficient advance visibility of the signals.

12.4 In this example (Photographs 12.1 and 12.2), traffic signals on a 40mph dual carriageway are located some 70m beyond the brow of an under bridge. Extended poles and duplicate primary signals mounted at high level ensure that the signals can be seen from an adequate distance.
Chapter 12
Designing for High-Speed Roads

Photo 12.3 Mast arm signal used on wide dual carriageway

12.5 This dual carriageway (Photograph 12.3) has a four lane approach to the signals. Drivers in the inner lanes could find that the low level primary signals were masked by large vehicles. The mast arm gives clear visibility for the signal on the approach. For all mast arm signals, the problems of maintenance of the signal head needs to be fully considered at the design stage.

12.6 Bright sunlight when the sun is low in the sky shining directly into a signal face can reduce visibility through phantom and washout effects. While this problem can occur at any signals it is particularly relevant at high speed sites where it is necessary for drivers to “read” the signals at greater distances.

12.7 These pictures at a 40mph site show the effect of low angle sun on a signal head with phantom effect tending to illuminate the red and amber signals and washout making the green arrow indistinct. The new standard segmented 200mm green arrows are brighter and less subject to washout.

Photo 12.4 (a) Red signal illuminated (b) Green arrow illuminated

12.8 The possibility of sun effects must always be considered at the design stage. It may be possible to make sure that at least one of the signals on an approach is not exposed to direct low-angle sun.

12.9 Where it is impossible to avoid sun shining directly into the signal faces, maintenance is of prime importance: keeping lenses and reflectors clean and lamps regularly replaced. Latest designs of signal heads have greatly reduced sun phantom and washout problems and these should always be used when installing new equipment or when upgrading existing equipment at sites subject to low angle sun illumination.
Stopping distance

12.10 At higher speeds, stopping distances increase and any tendency for vehicles to skid will be exacerbated. This example (Photograph 12.5) shows the use of anti-skid surfacing on the approach to a signal at a rural junction on a high-speed road.

![Photo 12.5 Anti-skid surfacing on approach](image)

Staging

12.11 Overlap staging (late start, early cut-off) should not be used on high-speed roads. (See Chapter 11 and TAL 2/03)

Reducing speed

12.12 To avoid the problems associated with high speeds at traffic signals, speed limits can be imposed. It is important that the change in speed limit is made very obvious if there are no apparent changes in the road characteristics.

12.13 At this site (Photograph 12.6), the speed limit has been reduced from 40mph to 30mph on the approach to signals. A yellow backing board has been provided behind the speed limit sign to improve visibility. (Yellow is the only permitted colour for a backing board in this situation.) This has been reinforced by road markings emphasising the change in speed limit and creating a “gateway” effect by adding a ghost island. Safety at the traffic signals. All these elements can combine to have an effect on speeds which cannot always be achieved by the imposition of a speed limit alone.

![Photo 12.6 Reducing speed on approach to traffic signals](image)

12.14 Photographs 12.7 and 12.8 show a dual carriageway with at-grade roundabouts which has had a 50mph speed limit imposed because of a history of accidents caused by vehicles approaching the roundabouts at high speed. A staggered crossing for pedestrians and cyclists (Toucan) is provided on one side of the roundabout (which is not itself signalled). A local speed limit of 30mph has been applied on the approaches to this roundabout. The lowering of speed can reduce the number and severity of accidents.
12.15 The recommended arrangement for staggered crossings on dual carriageways is left-right so that pedestrians (or cyclists) on the central reserve between the two halves of the crossing are facing oncoming traffic. This will tend to reduce the possibility of pedestrians stepping on to the carriageway without seeing approaching vehicles. In this case, the stagger is arranged right-left.

12.16 The reason for choosing this orientation of stagger is that it is necessary to provide a reasonable space between the roundabout and the crossing on the exit side. This is to prevent vehicles stopping at the crossing blocking the circulation of the roundabout. At the same time, it is important to keep the crossing path as close as possible to the pedestrian desire line (which is along the line of the road crossed by the dual carriageway).

(Note that zig-zag markings should be no more than 250mm from the edge of carriageway)
13. SIGNALISED ROUNDBOATS

13.1 Advice on the physical design of signalised roundabouts is provided in TD 50/99. Further advice on the effects of signal control on safety and efficiency; part time, partial and indirect signal control; design and analysis methodologies; control strategies; signing and signalling; and driver comprehension can be found in the Institution of Highways and Transportation’s Transport in the Urban Environment, Chapter 42: Signal-Controlled Gyratories (ISBN 0 902933 21 3).

Signing and Lining

13.2 Clear consistent direction signs and lane markings are an important aid to the efficiency and safety of signalised roundabouts. The photographs on this page were taken from a typical larger roundabout or gyratory system (site 1), where the lanes are allocated to destinations which are shown on the carriageway; on signs in the verge and on overhead gantry signs.

13.3 The allocation of lanes has been designed to equalise the use of lanes to aid capacity and to remove any need for users to change lanes. Since the completion of the scheme there has been a marked reduction in accidents and delays at this roundabout.

13.4 It is usually helpful for lane markings to spiral outwards following the natural line as vehicles approach the exit appropriate to their destination. Continuing the lane markings through conflict areas can help to guide drivers into the correct lane.

13.5 In the above example the line for traffic entering from the left of the photograph is picked out using dots. Crosses (see Photograph 13.3) have been introduced elsewhere for the same purpose. (Note that these markings are not prescribed signs and require special authorisation).

Photo 13.1 Direction signs and lane markings (site 1)

(Note: the sign design is incorrect as horizontal bars are used only to link two lanes going to the same destination. See diagram 2019 in TSRGD)

Photo 13.2 Lane markings through conflict area (site 1)
13.6 Throughput may be improved by segregating heavy streams of traffic from neighbouring lanes using islands or chevron markings as shown in Photograph 13.4.

13.7 Note that hatching should be avoided on the approach to a pedestrian crossing point. Hatching alongside pedestrian crossings is potentially hazardous and at crossings with zig-zags the use of hatching is unlawful.

**Signal Head Location**

13.8 For small roundabouts there is potential for drivers interpreting the wrong signals if signal stop lines are closely spaced. To avoid this potential for confusion one external stop line at site 2 was set back to give a distance of 50 metres to the first internal stop line. This solution is not entirely satisfactory in this case because there is a tendency for some drivers to stop in the reservoir between the stop line and the circulatory carriageway.

13.9 When there are more than two lanes, it is often necessary on signalised roundabouts, to provide overhead signals to ensure adequate signal visibility from the central lanes. This is frequently achieved using a head located on a mast arm. A single mast arm allows an outreach of up to 6.5 metres allowing a signal head to be positioned approximately 5 metres from the kerb. For four-lane approaches it may be necessary to consider two mast arms but a more elegant solution could be the portal frame adopted at site 1.
13.10 Care is required when designing the location of secondary signals to prevent signal aspects being visible from the conflicting approach which could lead to confusion or anticipation of changes in the signals. Long signal hoods or in extreme cases, vertical louvres, have been used to minimise this problem. The problems of secondary signal visibility by drivers on opposing approaches may be addressed in part by using closely-associated secondary signals on the approaches to the roundabout, particularly in association with pedestrian crossings.

Design of Cable Runs

13.11 At large signalised roundabouts, a single controller usually controls several nodes. This can mean there are long runs of cable carrying the signal phases and providing earthing. The resulting drop in voltage may require the use of thicker conductors in order to comply with BS 7671. Increased conductor size can be
provided simply by using more than one cable core for the same supply. A practice adopted at Tingley Roundabout to avoid congesting the cable ducts and controller cabinet with these extra cables has been to install cable termination cabinets at each node. These cabinets allow a connection to be made between a single feed from the controller to several cable feeds to the signal poles.

important when designing the layout and method of operation of such a crossing to take into account the potential for queues to spill back onto the roundabout. In addition to the off-road cycle route that incorporates the Toucan, a cycle lane is provided on the carriageway through the roundabout.

Pedestrian and Cyclist Facilities

13.12 The introduction of traffic signals to an uncontrolled roundabout provides an opportunity for including signalised crossings for both pedestrians and cyclists. Photograph 13.10 shows a Toucan situated across an exit from site 2. It is
14. MAINTENANCE AND INSTALLATION ISSUES

Introduction

14.1 Over the lifetime of a traffic control system, maintenance represents a very large part of the cost of the scheme. Designing a scheme for ease of maintenance can not only reduce costs but will make it more likely that the system is correctly maintained resulting in greater efficiency and safety.

i) Special paint finishes are available that are effective in discouraging fly posting. They are also less attractive to graffiti artists.

ii) A clear reference number is useful for identifying equipment in fault reporting, particularly when reports are received from police or members of the public.

iii) Having a cabinet which does not require rear access allows it to be sited against the footway boundary. This can be valuable for siting housings on narrow carriageways.

iv) Having separate pillars for electricity (left) and communications circuit (right) provides clear demarcation for different maintenance authorities and allows them to control access to their particular equipment.

Photo 14.1 Signal Controller

14.2 The example of a signal controller illustrates several maintenance related issues.

i) Special paint finishes are available that are effective in discouraging fly posting. They are also less attractive to graffiti artists.

ii) A clear reference number is useful for identifying equipment in fault reporting, particularly when reports are received from police or members of the public.

Photo 14.2 Signal obscured by trees
Maintaining visibility

14.3 The example in Photo 14.2 shows how natural growth can obscure a signal with possible safety implications. The problem may not have been obvious at the time of design. Where possible, signs and signals should be sited where their visibility is not prejudiced by growth of trees or plants. Where it is unavoidable, regular trimming of the tree growth must be incorporated in the maintenance arrangements. See also TD24 (All Purpose Trunk Roads: Maintenance of Traffic Signals) 2.3.3. and 3.1.4.

Detector installation

14.5 Slot cutting loop tails through pressed concrete kerbs is a quick and economical method of detector installation. At sites where loop failure is common and regular re-cutting of loops is necessary this can soon lead to serious damage to the integrity of the kerb. Using a widened joint between kerbs reduces kerb damage.

14.6 Alternative methods of installing detectors include the installation of carriageway boxes for the termination of detector loop tails which are connected via a duct under the kerb to a footway box and ducting system back to the controller. Although this is very much more expensive than simple slot cutting, where regular loop replacement is considered likely it provides a quick and sound method for connecting re-cut loops without damage to the kerb.
14.7 Loop detectors need particular consideration for installation and maintenance because of the effect on traffic flow when slot cutting and loop installation are undertaken. On an approach to traffic signals with a central reserve where a single traffic stream occupies two lanes it is possible to use a single loop spanning two lanes for System D detection but this requires the closing of both lanes for installation or re-cutting of the loops. If separate loops are used for each lane (with the offside loop connected to a duct box in the central reserve) one lane can be kept open while each loop is worked on. See also LTN 1/98.(Chapter 10)

**Pole boxes**

14.8 The use of footway boxes at the base of each pole, aligned with the entry slot in the pole, can make the maintenance of cabling systems very much more straightforward. Poles can be replaced and additional cables to the pole can be installed with minimum disruption to the footway and better control over cable connections and joints.

**Siting of controller**

14.9 One of the factors affecting the choice of site for a controller is that it should be located where the maintenance engineer has a good view of the junction when working at the controller.

14.10 At this town centre site, the narrow, busy footways, shop fronts and colonnaded buildings limit the possible location for the controller. The chosen location has adequate footway width and is ideally placed for the maintenance engineer to see all arms of the junction. For other advice on siting controllers see LTN 1/98 (7.0.3)

14.11 Consideration must also be given to where maintenance vehicles can be parked, particularly for installations on faster roads. This example is of a staggered pedestrian crossing on an urban dual carriageway. The controller is sited on a wide central reserve outside the guard railing. A dropped kerb downstream of the junction allows a maintenance vehicle to park close to the controller. Access from the downstream side of the crossing is the safer alternative as maintenance vehicles turning on to or leaving the central reserve cannot mask pedestrians on the
crossing. Also, when the vehicle is leaving the central reserve it can make use of the gaps in traffic created by the crossing signals.

14.7 Parking provision for maintenance vehicle
15. SHUTTLE WORKING

Introduction

15.1 Shuttle working, permanent alternate one way working, is necessary where the width of a section of road is physically constrained preventing two directional flow. Where the length of the section is very short and there is intervisibility from each end, it is often possible to establish a priority system with one direction giving way to the other. In other situations it is necessary to impose signal control to ensure safe and efficient working.

15.2 As with other forms of signal control the aim of shuttle working signals is to minimise delay and to ensure safety. Minimising delay requires the detection of approaching vehicles and the adjustment of green times to the levels of the competing demands. Safety requires that the system should ensure that vehicles are clear of the shuttle section before the right of way is reversed.

15.3 With short lengths of shuttle working a fixed clearance may be adequate but where longer lengths are used the clearance times need to be adjusted by extending the all-red period by detectors which monitor the passage of vehicles.

Use of Above Ground Detection

15.4 The first example (Photographs 15.1, 15.2, 15.3) is of a length of coastal road close to an unstable cliff edge. Shuttle working has been applied to a 300m length as a temporary measure to keep traffic from the side of the carriageway nearest the cliff edge until permanent stabilisation works are carried out. Above ground detection was chosen for the speed of installation, the lower cost (for a temporary system) and to minimise excavation work.
15.5 Microwave vehicle detectors (as used for vehicle detection at Pelican and Puffin crossings) are mounted on poles in pairs (one facing each way) approximately 80m apart. Where detectors are facing one another, they must be tuned to different frequencies to avoid interference and faulty operation. The detectors are set to respond to moving vehicles in either direction. The detecting range of the detectors is close to that of the spacing between the poles meaning that vehicles are almost always in range of two different detectors. This gives some redundancy in the event of equipment failure and minimises the possibility that a vehicle may be missed by the system.

15.6 Microwave detectors are also installed on the primary and secondary signals at each end of the system to detect approaching vehicles.

15.7 The method of control employed is a short minimum green extended by the approach detectors and an all-red period extended by the detectors in the system. This results in efficient working with green appearing to waiting drivers a few seconds after the last vehicle leaves the single lane section. To avoid vehicles being trapped at the stop line, permanent demands are inserted for each direction. Although in theory only a very short minimum all-red (one second) is required, in practice a minimum of four seconds is used. This is to avoid the situation where a driver approaches the signals on green when there are no other vehicles in the system (green selected by the permanent demand setting) and the signals change to amber before the approach detector picks up his vehicle. Under quiet conditions the driver may be tempted to enter the system after the red has appeared. If the all-red has expired before the vehicle is picked up by the detectors in the system, the green for the opposing direction will appear before the first vehicle has cleared possibly resulting in opposing vehicles meeting in the single lane section. The longer minimum all-red means that vehicles crossing the stop line in the first few seconds of red will extend the all-red until the vehicle has cleared the system.

15.8 The opportunity has been taken to use the closed-off half of the carriageway as a cycle way. This avoids the problem of having to extend the all-red sufficiently to clear slow moving bicycle.

**Narrow Bridge**

15.9 The second example (Photographs 15.4, 15.5) is of shuttle working on a narrow bridge over a railway. The bridge is within a 20mph traffic calmed zone and is subject to weight and width limits.

15.10 The embankments taking the road up to the bridge are subject to settlement which causes cracking in the road surface. For this reason above ground detectors are preferred for extending the all-red period.

15.11 The green stages are called and extended by above ground detectors mounted on the primary signal poles. Loop detectors are installed at the stop lines which also call the green stages to prevent vehicles being trapped.
15.12 Part of the carriageway width on the bridge and approaches is reserved for pedestrians and cycles and this is reinforced by a physical barrier.

15.13 The total length of the shuttle working between stop lines is 250m of which 40m is the bridge itself. There are four single pole-mounted above-ground detectors installed along the length of the shuttle lane. Because of the horizontal and vertical curvature these are carefully sited to give a continuous “view” of vehicles over the whole length.

15.14 The method of operation of this scheme is for the signals to revert to all-red in the absence of demands. This minimises delay in periods of quiet traffic as an approaching vehicle will receive immediate right of way if there are no vehicles in the system.

15.15 The system will also allow the same green to be called again while a vehicle is still within the system when a second vehicle in the same direction is detected.

Use of Loop Detectors

15.16 The third example (Photographs 15.6, 15.7) is of a 200m length of shuttle working through a village in an Area of Outstanding Natural Beauty. The adoption of shuttle working allows an adequate width traffic lane and a narrow footway to be maintained through the village. Loop
detectors are installed at 40m spacing along the shuttle working length. These provide fixed extensions to the all-red. The length of the extensions are set to cater for the speed of cyclists. A double diamond layout has been employed for the all-red extending loops to increase the sensitivity to two wheeled vehicles.

15.17 The fixed extensions from the loop detectors cannot guarantee clearance for the slowest cyclist but the vehicle lane is wide enough to allow cyclists to pass vehicles in the opposing direction safely.

Under a narrow railway bridge

15.20 The fourth example (Photographs 15.8, 15.9, 15.10, 15.11) is of shuttle working under a narrow arch railway bridge. With low traffic volumes and good visibility it might be possible to operate without signals. At this site, because of the alignment of the road there is no long distance visibility through the bridge and shuttle working signals are used to ensure safety. The length between stop lines is 80m. There is intervisibility between stop lines and fixed all-red clearance times are used. Loops or infrared detectors could be used to extend the all-red to give added clearance for slow moving vehicles (including cyclists).

15.21 As with the third example, control is complicated but entrances at each end. In this case at one end there is a garage forecourt which exits between the stop line and the bridge but before the signals. As with the third example, traffic turning left out of the forecourt have a detector to call the green through the bridge.

15.22 At the other end there is the station approach which enters the main road between the stop line and the bridge after the primary signal but from where the secondary is visible. This entrance is priority controlled with “Give Way” markings but is equipped with two loop detectors to ensure that emerging vehicles can demand the green through the bridge even if there is no traffic on the main road. The siting of these loop detectors is critical so that it detects vehicles waiting to turn right out of the station approach but not vehicles waiting to turn left and so that it is not operated by vehicles turning into the station approach.
Photo 15.8  Stop line to stop line intervisibility

Photo 15.9  Garage forecourt exit on left (beyond stop line)

Photo 15.10  Station approach on right

Photo 15.11  Detector for right tuning vehicles from station approach
Low bridge with blind approach

15.23 The fifth example (Photographs 15.12, 15.13, 15.14) is of a very low (8 ft 6in) under bridge on a lightly trafficked road. Although there is a clear width of 5.5m between walls under the bridge this is insufficient to give an adequate running lane in each direction while making provision for pedestrians and cyclists, particularly because of the blind approach to the bridge.

![Photo 15.12 Blind approach to bridge](image)

15.24 Note that low bridges being struck by vehicles is a major problem with potentially disastrous consequences. It is important to maintain maximum visibility of the bridge and its signing. At this site the visibility is partially obscured by foliage.

15.25 The carriageway through the bridge has been deliberately kerbed down to 2.5m to reduce speed and to prevent any attempt at overtaking.

15.26 The shuttle working section is 130m between stop lines of which 40m is the bridge itself.

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15.27 Stop line and above ground detectors are used to call and extend the green periods. Loop detectors at 10m centres along the length of the shuttle working are used to extend the all-red clearance period.
16. WIGWAG SIGNALS

Introduction

16.1 Wigwag signals, comprising two red signal aspects arranged horizontally and a single amber aspect below them, are used for a number of applications where it is necessary to stop traffic regularly but relatively infrequently. These applications include accesses for emergency vehicles (fire appliances, ambulances, etc), swing and opening bridges, airfield runway crossings and railway level crossings. The requirements for the equipment are set out in MCE 109 (Fire and ambulance stations) MCH 1502 (Moveable bridges) and MCE 0113 (Airfields). Note that wigwags for railway crossings have different requirements and any scheme involving a railway crossing has to be approved by the Railway Inspectorate. The requirements are set out in 'Railway Safety Principles and Guidance Part 2, section E Guidance on level crossings' (generally known as 'The Blue Book'), which is published by the Railway Inspectorate which is part of the Health and Safety Executive.

Wigwags for emergency vehicles

16.2 Wigwags are not essential at every point where emergency vehicles emerge on to the public highway. Where visibility and access is good and traffic speeds are low there may be little problem for emergency vehicles using sirens and blue beacons. If the exit from the emergency vehicle station is into a traffic signal controlled junction the access may be allocated its own stage with a hurry call facility operated from within the station.

16.3 This example is of an installation in a location close to a city centre. The fire station is located on the inside of a bend giving poor visibility of the exit for approaching vehicles. The exit is on to a one-way street, requiring wigwags in one direction only.
16.4 The pushbutton arrangement is specified in MCE 109. Indicators showing mains power on and red lamp failure (with cancellable audible alarm) must be provided. The faceplate must have a three light wigwag which operates in parallel with the road signals comprising a single amber and horizontal blue (or white) wigwags. The lamps must be visible within the station by the vehicle crew. Additional remote pushbuttons may be provided (for example, where a ‘turn out’ may be required from the practice yard) as well as duplicate miniature or full size blue (or white) wigwags. The pushbutton should be located where the last person aboard, usually the officer in charge, can activate it. This ensures a consistent time onto the highway.

16.5 The second example is of an ambulance station on a busy city radial at the point where the 30mph speed limit changes to 40mph. Although visibility is good, heavy traffic flow and relatively high speeds mean that wigwags are required.
16.6 A full size blue wigwag is provided at the point where the vehicles emerge on to the carriageway to confirm to the ambulance drivers that traffic is being shown the red wigwag stop signal.

16.7 An access to a highways compound is alongside the ambulance exit and this is equipped with its own red wigwag signal.

16.8 It should be noted that external blue wigwags may use full size components from normal traffic signals but must still be in the same horizontal configuration. Approval may be given to a reduced width wigwag (880mm wide rather than 1365mm) where there are location difficulties but wigwags arranged vertically in a standard three aspect signal head (Photos 16.7 (a)(b) are not prescribed in TSRGD, are unlawful and will not be authorised.

**Moveable bridges**

16.9 This is an example of wigwags installed at a moveable bridge on the entrance to a busy yachting harbour. Note that the current Traffic Signs and General Direction prescribe red and white borders to the wigwag backing boards. The (Note: red and white borders are required on all systems installed since 1994)
wigwags in this example have white borders which were prescribed prior to 1994. While it is not a legal requirement for signs installed before the 1994 regulation to be modified all new wigwag signs are required to have red and white borders.

16.10 At moveable bridges, barriers are also required and the barriers and the bridge mechanism must be interlocked so that neither the barriers nor the bridge can be operated until the wigwags are flashing. The full requirements are detailed in MCE 1502.

16.11 Unlike emergency vehicle accesses, moveable bridges are sometimes open for extended periods because of faults or maintenance procedures. Consideration has to be given to vehicles which may be held at wigwags for an indeterminate period and need to find an alternative route. If, as in this case, there is no diversion available at the bridge approach and insufficient space for large vehicles to turn round, advance signs are needed to give warning to approaching traffic that the bridge is closed to road traffic.

16.12 In this example, a variable message sign using rotating planks is located one kilometre in advance at the point at which vehicles must divert to avoid using the bridge. This is in the form of a standard direction sign which changes the destinations indicated when the bridge is closed for a significant time.

16.13 Note that the sign is illuminated and equipped with flashing amber lamps to alert drivers to the change in destination indicated.

16.14 The remote signs as well as the wigwags, barriers and the bridge itself are operated from the harbourmaster’s office which has a clear view of the bridge. It is essential with moving bridges that the operator is able to make a visual check that the bridge and its approaches are clear before the system is operated.

Photo 16.9 Lifting barriers on bridge

Photo 16.10 Variable message direction sign for diverting traffic

December 2003
17. DUMMY PHASES

Introduction

17.1 Traffic signal controllers built to the TR 2210 specification are phase based controllers. (See Glossary for a complete definition and explanation of stages and phases). Under Vehicle Actuated control mode, demands are registered for phases and the controller selects a stage in which that phase has right of way. Because a phase may run in more than one stage, this allows the controller to select the stage which best serves the total of all the phase demands.

17.2 A “real” phase sets the red, amber and green times for the signals controlling a traffic stream. Within the controller, minimum, maximum and extension times can be set for the phase and other phases which conflict with or oppose it can be defined, together with minimum intergreen times between conflicting phases. (See Glossary for definitions of “conflicting” and “opposing” phases) The allocation of phases to stages is also defined. A dummy phase can also be allocated to a stage, have minimum, maximum and extension times defined, be considered to oppose other phases and have intergreen timings set. What distinguishes it from a real phase is that it is not connected to any signals and does not control a traffic stream.

17.3 This chapter gives examples of how dummy phases can be employed to achieve the designer’s requirements. The way the techniques can be implemented may vary between makes of controller. There may also be other methods of configuring a controller to achieve the same results without using dummy phases

Stages without exclusive phases

17.4 In some staging arrangements there are stages which run phases which also run in other stages. If Phase A runs in stages 1 and 2 and Phase D runs in stages 2 and 3, there is no set minimum time for stage 2. Even if the stage sequence requires that stage 2 appears between stages 1 and 3, it can be of zero length. This may be unacceptable for several reasons. One of them is that under UTC control a zero length stage 2 will not be detected and an error will be reported. This can be prevented by allocating a dummy phase to stage 2 with a minimum green assigned to it. In the case of the UTC problem this may need to be only of the order of two seconds. Another situation may be if there is a requirement to make Stage 2 a priority stage. A dummy phase assigned to this stage can be used as the priority phase so that a demand for the dummy phase is inserted when priority is required.

Fig 1. Stage without exclusive phase
Change of stage without terminating a phase.

A stage is defined as ending when the first of its associated phases terminates. It is possible to have staging arrangement where a stage changes but no real phase terminates. An example of this is where a traffic phase has a parallel pedestrian phase which is only to be called when demanded. Without a pedestrian demand, the traffic phase will run without the pedestrian phase changing to green. On receipt of a pedestrian demand it is required that the pedestrian phase changes to green while the traffic phase remains on green. This can be programmed with a dummy phase by defining two stages – the first running the traffic phase and the dummy phase and the second running the traffic phase and the pedestrian phase. When the first of these stages is running and a pedestrian demand is received the dummy phase terminates and the pedestrian phase runs.

Use of dummy phases with all-red stages

17.5 By definition, no real phase has right of way during an all-red stage. If an all-red stage is required to be extended between a minimum and a maximum time this can be achieved by allocating a dummy phase to it. This has particular application to shuttle working where an extendible all-red is necessary to optimise the time given to clearing the shuttle working section before allowing opposing traffic to have right of way. An all-red stage can be extended by detectors without the use of a dummy phase, but the dummy phase gives more flexibility. With a dummy phase running in the all-red it is possible to set an “intergreen” between the dummy phase and the next traffic phase. This gives a settable additional all-red following the expiry of the last extension of the all-red.

17.6 Where shuttle working is on a stretch of road with a significant gradient, it is possible to define two different all-red stages, each with its own dummy phase allocated. This allows longer extensions to be used for clearance in the uphill direction than in the downhill direction.

17.7 A similar approach can be used where it is necessary to vary the intergreen (for certain times of the day or specific vehicles such as LRT). A dummy phase can be brought into use by time switch or detector to create a longer intergreen.

Reversion to a dummy phase

17.8 For shuttle working at quiet periods it can be efficient to arrange for the signals to revert to all red in the absence of demands so that the next vehicle to arrive can gain immediate right of way. This means that the controller will go to all-red when the extensions to the green expire without a demand for the opposing phase. To ensure that the different directions are served in turn when demands for both directions are registered before the maximum time of the all-red stage is reached, two all-red stages maybe defined with the same dummy phase allocated to each of them. The signals are set to revert to the dummy stage in the absence of demands. This causes the controller to select the all-red stage next in the cycle and will then give right of way to the opposite direction from the previous green stage if both are demanded.

Using a dummy phase will all-red can also provide flexible reversion to all red at junction signals at quiet periods. The controller can be programmed to revert to all-red after a preset period when no demands or extensions are recorded. The signals then be set to change to red/amber on the appropriate phase immediately a demand is received.

Using a Dummy Phase to create a preset Maximum Green

17.9 Under VA control, minimum and maximum greens are allocated to each phase. When a phase has right of way, a demand for an opposing phase starts the maximum green timer for the phase. The green for the phase is terminated when either the extensions for the phase expire or the maximum time is reached. Consequently, the actual maximum time the green appears for is the maximum green time plus any green time before a demand for an opposing phase is registered. A dummy phase can be used to start the maximum green timer at the beginning of
A demand for a real conflicting phase can then be served as soon as the specified phase has run for the preset maximum green or immediately (if the maximum green has already timed off before the conflicting demand is registered). In the absence of any demands for a real conflicting phase, the specified phase remains on green as is normal for VA working.

17.10 The dummy phase, which is not allocated to any stage and is never run, is designated as opposing the specified phase. When the specified phase gains right of way, a non-latching demand is inserted for the dummy phase which starts the maximum green timer for the specified phase. The demand is cleared when the specified phase loses right of way.

**Dummy phases and UTC**

17.11 In UTC, “G” bits are used to confirm that certain stages are running. Sometimes it is preferable to allocate a single G bit to more than one stage where these always run in sequence. In normal operation, all G bits disappear during interstage periods. By allocating the same dummy phase to all stages required to share the same G bit and associating that G bit with that dummy phase, the G bit will appear continuously through all the required stages and the interstage periods between them.
18. BIBLIOGRAPHY

The following documents contain advice and information relevant to the design of traffic control and information systems. Ownership of the documents is shown in brackets. Contact details are at the end of the bibliography.

The Traffic Signs Regulations and General Directions (DfT)
The Traffic Signs Manual (Chapter 8) (HA)
Specification for Highway Works (HA)
SH6/73 Criteria for Traffic Light Signals at Junctions (Scotland) (HA)
TA15 Pedestrian Facilities at Traffic Signal Installations (TSO)
TA16 General Principles for Control by Traffic Signals (TSO)
TA22 Vehicle Speed Measurement on All-Purpose Roads. (TSO)
TA67 Providing for Cyclists (TSO)
TA68 The Assessment and Design of Pedestrian Crossings (TSO)
TA82 Installation of Traffic Signals and Associated Equipment (LTN1/98) (TSO)
TA84 Code of Practice for Traffic Control and Information Systems on All-Purpose Roads (TSO)
TD7 Type Approval of Traffic Control Equipment (TSO)
TD24 All Purpose Trunk Roads: Maintenance of Traffic Signals (TSO)
TD33 Use of VMS on All Purpose and Motorway Trunk Roads (TSO)
TD35 MOVA System of Traffic Control at Signals (TSO)
TD50 The Geometric Layout of Signal-controlled Junctions and Signalised Roundabouts (TSO)
TD60 The use of VMS on All Purpose and Motorway Trunk Roads (TSO)
HA19 Safety Audits (TSO)
HA42 Safety Audits (TSO)

TAL 4/91 Audible and Tactile Signals at Pelican Crossings (DfT)
TAL 5/91 Audible and Tactile Signals at Signal Controlled Junctions (DfT)
TAL 10/93 "Toucan", an unsegregated crossing for pedestrians and cyclists (DfT)
TAL 4/95 The “SCOOT” Urban Traffic Control System. (DfT)
TAL 5/96 Further Development of Advanced Stop Lines. (DfT)
TAL 3/97 The “MOVA” Signal Control System. (DfT)
TAL 4/98 Toucan Crossing Development. (DfT)
TAL 7/99 The “SCOOT” Urban Traffic Control System. (DfT)
TAL 16/99 The Use of Above Ground Vehicle Detectors. (DfT)
TAL 17/99 Code of Practice for Traffic Control and Information Systems (this is to introduce the Code of Practice and not the document itself) (DfT)
TAL 7/00 SCOOT Gating. (DfT)
TAL 8/00 Bus Priority on SCOOT. (DfT)
TAL 9/00 SCOOT Estimates of Emissions from Vehicles. (DfT)
TAL 1/01 Puffin Pedestrian Crossing. (DfT)
TAL 6/01 Bus Priority. (DfT)
TAL 1/02 The Installation of Puffin Pedestrian Crossings (DfT)
TAL 2/03 Signal-control at Junctions on High Speed Roads (DfT)
T/INF/249 How to use a Puffin crossing. (DfT)
LTN1/95 The Assessment of Pedestrian Crossings (DfT)
LTN2/95 The Design of Pedestrian Crossings (DfT)
LTN 1/97 Keeping Buses Moving (DfT)
LTN 1/98 The Installation of Traffic Signals and Associated Equipment (DfT)
Guidance on the Use of Tactile Paving Surfaces. (DETR) (DfT)
<table>
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<th>No.</th>
<th>Title</th>
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<th>Notes</th>
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<tbody>
<tr>
<td>MCE 0109</td>
<td>Equipment to Control Traffic Signals (WIG-WAG) Adjacent to Fire/Ambulance Stations</td>
<td>(HA)</td>
<td></td>
</tr>
<tr>
<td>MCE 0113</td>
<td>Equipment to Control Traffic Signals (WIG-WAG) Adjacent to Airfields</td>
<td>(HA)</td>
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<tr>
<td>MCH 1502</td>
<td>Operational Requirements for Equipment to Control Traffic Signals at Movable Bridges</td>
<td>(HA)</td>
<td></td>
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<tr>
<td>RR 67</td>
<td>The prediction of saturation flows for road junctions controlled by traffic signals.</td>
<td>(TRL)</td>
<td></td>
</tr>
</tbody>
</table>

These publications are available from the following:

- **DfT**: Department for Transport  
  76 Marsham St.  
  London SW1P 4DR

- **HA**: Highways Agency  
  Plans Registry  
  Temple Quay House  
  2 The Square  
  Temple Quay  
  Bristol BS1 6HA

- **TSO**: The Stationery Office  
  PO Box 29  
  Norwich NR3 1GN

- **TRL**: Transport Research Laboratory  
  Old Wokingham Rd  
  Crowthorne  
  Berkshire RG45 6AU
19. HISTORY

Issue A December 2003

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December 2003
ANNEX A: GLOSSARY

Introduction

A.1 This Glossary brings together definitions of terms used in traffic control and associated areas of traffic engineering. Some of these terms are included in BS 6100: Glossary of Building and Civil Engineering Terms subsection 2.4.1 : 1992 Highway Engineering. Some of the same terms are defined in other published standards and advice notes, often with slightly different definitions. This Glossary aims to provide definitions which are self-consistent and accurately reflect current usage.

Phase and Stage

A.2 The use of the terms “phase” and “stage” requires particular explanation. These terms have consistently given rise to confusion and misuse.

A.3 The concept of “stage” is of a particular pattern of movements permitted by the traffic signals. The signal cycle is made up of a series of stages.

A.4 Confusion arises because the term “phase” (with its dictionary meaning of a period of time forming part of a sequence) is used to express the concept of “stage” in some other English speaking countries (such as Australia and the USA). Also, in most other European languages this concept uses a term (e.g. “la phase” or “die Fase”) which has a similar root.

A.5 In the UK, the term “phase” was adopted based on its electrical usage (two-phase or three-phase AC electrical supply). In this application the concept of phase is that of cables carrying alternating voltages which are similar (sinusoidal, same amplitude and frequency) but out of phase with each other. In its application to a simple traffic signal control between two traffic streams, each stream receives essentially similar indications, cycling alternately red and green with the same frequency (cycle time) but out of phase with each other so that one is red when the other is green and vice-versa. The definition of phase is therefore one of a sequence of conditions applied to a traffic stream.

A.6 Further confusion arises from the fact that with simple signals the two terms can often be interchanged without penalty. It may be reasonable to say that “Stage 1 is the main road” meaning that in Stage 1 the main road traffic is the permitted movement. At the same time it may be equally reasonable to say that “Phase A is the main road” meaning that the “sequence of conditions” which define Phase A is applied to main road traffic. Control at such a simple junction may be described correctly as two-stage control or two-phase control. When the main road is receiving a green signal it may be said that “Stage 1 is running” or that “Phase A is running” (meaning that Phase A is green).

A.7 With more complex control, where the number of stages does not equal the number of phases, the distinction between stage and phase is important. Control may be “staged based” or “phase based”. In each case the controller selects a stage. Under stage control, a specific stage is demanded. Under phase control, a phase is demanded and the controller selects the most appropriate stage from the alternatives which cause that phase to run.

A.8 Within the traffic signal controller, the term “phase” is extended to cover the electronic equipment which controls the “sequence of conditions” which make up the phase. For several reasons, particularly the need for red lamp monitoring of individual approaches, it is now conventional that opposing traffic streams which always run together in the signal cycle are controlled separately by the controller. Although in traffic engineering terms the opposing streams share the same phase, in the controller they are treated as separate phases. This must be recognised in the specification of the controller and on the layout plan where signal heads are lettered according to the phase to which they belong.
European Terms

A.9 With the harmonisation of standards and specifications within Europe, new documents are being produced which exist in three languages, English, French and German. There is no agreed standard of equivalents between terms used in the three languages but some established UK terminology has been changed in these documents to bring them closer to the term or concept used in other languages.

A.10 Particular differences in the English versions of European Standards and Specifications include:

i) the use of “yellow” in place of “amber” as this correlates with colour definitions in other international specifications

ii) the use of “signal group” in place of “phase” to avoid the confusion set out above

iii) the use of “optical unit” in place of “aspect” for an element of the signal head.

iv) The use of “background screen” in place of “backing board”

A.11 In this document, standard UK terms are used and defined to accord with other specifications, standards and regulations currently in use.
### Definitions

#### Control and analysis terms

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<th>Definition</th>
<th>Glossary</th>
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<td>141 form</td>
<td>Specification forms for a traffic signal controller meeting specification TR 0141 (now superseded by TR 2210)</td>
<td>conflict</td>
</tr>
<tr>
<td>all red</td>
<td>A condition of traffic signals where all movements receive a red signal</td>
<td>conflicting phases</td>
</tr>
<tr>
<td>all-red period</td>
<td>Period during the change from one phase green to the next when all phases show red</td>
<td>coordination</td>
</tr>
<tr>
<td>amber</td>
<td>The particular colour in the yellow part of the spectrum used in traffic signals. The same as the term “yellow” used in European specifications.</td>
<td>cycle</td>
</tr>
<tr>
<td>arrow</td>
<td>A signal aspect with a symbol indicating a direction</td>
<td>cycle time</td>
</tr>
<tr>
<td>arterial reversion</td>
<td>Reversion to a selected stage in the absence of demands</td>
<td>demand</td>
</tr>
<tr>
<td>call</td>
<td>The placing of a demand for a stage or phase</td>
<td>demand dependent</td>
</tr>
<tr>
<td>call/cancel</td>
<td>The function of a detector which calls a stage or phase when occupied for a specified time but for which the demand is cancelled if it subsequently becomes unoccupied for a specified time before the demand matures</td>
<td>dummy phase</td>
</tr>
<tr>
<td>condition</td>
<td>The pattern of illumination of aspects of a signal head</td>
<td>early cut-off</td>
</tr>
</tbody>
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Note: The glossary entries are sourced from the Traffic Control System Design (Compendium of Examples) Annex A of the MCH 1969 Issue A document. The glossary provides definitions for various terms related to traffic signal control and analysis. The glossary is intended to aid in understanding the terminology used in traffic control systems.
<table>
<thead>
<tr>
<th>Glossary Item</th>
<th>Definition</th>
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<tr>
<td>effective green</td>
<td>For a given actual green period, the length of green time, which when multiplied by the saturation flow, represents the maximum amount of traffic which will be able to pass in that green period.</td>
</tr>
<tr>
<td>exit</td>
<td>At a junction, the portion of an arm which carries traffic away from the junction.</td>
</tr>
<tr>
<td>extension</td>
<td>Continuation of the green signal that results from a request made by a vehicle or pedestrian that has right of way. (May also be applied to a red signal).</td>
</tr>
<tr>
<td>fixed time</td>
<td>Traffic signal control where the duration of the red and green signals and the length of the cycle is fixed.</td>
</tr>
<tr>
<td>gating</td>
<td>The use of traffic signals to restrict the flow of traffic at a point with the aim of improving the efficiency of traffic flow at a downstream point.</td>
</tr>
<tr>
<td>green</td>
<td>The colour of the aspect giving right of way at signals.</td>
</tr>
<tr>
<td>green arrow</td>
<td>A symbol incorporated in a green aspect to indicate permitted direction of movement.</td>
</tr>
<tr>
<td>green wave</td>
<td>A control strategy for a linear system of traffic signals which attempts to synchronise the start of green at a junction with the arrival of a platoon from the preceding junction.</td>
</tr>
<tr>
<td>intergreen (period)</td>
<td>Period between the end of the green signal giving right of way for one phase, and the beginning of the green signal giving right of way for the next phase.</td>
</tr>
<tr>
<td>intergreen matrix</td>
<td>On a vehicle actuated controller, a matrix of intergreen timings between pairs of phases.</td>
</tr>
<tr>
<td>interstage period</td>
<td>The period between the end of one stage and the start of the next stage.</td>
</tr>
<tr>
<td>invitation period</td>
<td>The period of display of a steady green man to pedestrians at traffic signals.</td>
</tr>
<tr>
<td>isolated control</td>
<td>Control of a signalled junction where the timings are not related to neighbouring junctions.</td>
</tr>
<tr>
<td>lane control signals</td>
<td>Overhead signals comprising a downward pointing green arrow and a red cross to indicate the permitted direction of movement on a reversible traffic lane.</td>
</tr>
<tr>
<td>lane indication arrows</td>
<td>Road markings in the form of arrows to indicate which traffic movement(s) may use a lane.</td>
</tr>
<tr>
<td>late release</td>
<td>An alternative term for “late start”</td>
</tr>
<tr>
<td>late start</td>
<td>A condition in which one or more traffic streams are permitted to move before the release of other traffic streams which are permitted to run with them during the subsequent stage.</td>
</tr>
<tr>
<td>LINSIG</td>
<td>A computer program for the analysis of isolated traffic signals originally developed in Lincolnshire.</td>
</tr>
<tr>
<td>local control</td>
<td>A form of control at a signal installation which is not subject to influences from other junctions or area control systems.</td>
</tr>
<tr>
<td>lost time</td>
<td>The time during a cycle which cannot be used as effective green to one or more phases.</td>
</tr>
</tbody>
</table>
| **maximum green**  
| **(maximum running period)**  
| The time that a green signal to vehicles can continue after a demand has been made by traffic on another phase.  
| **minimum green**  
| **(minimum running period)**  
| Duration of the green signal, following the extinction of a red–amber signal, during which no change of signal lights can occur.  
| **mode**  
| A particular method of operation for a hardware or software device.  
| **MOVA**  
| Microprocessor Optimised Vehicle Actuated strategy based on minimising stops and delays which maximises capacity at a single controlled junction.  
| **offset**  
| The difference in time between a specific point in the cycle at a junction and a reference point.  
| **opposed right turn**  
| A right turning movement which is in conflict with on-coming traffic  
| **opposing phases**  
| Phases which are not permitted to run together by the controller but which do not control conflicting traffic movements (see “conflicting phases”)  
| **opposing traffic**  
| Traffic proceeding in the opposite direction  
| **OSCADY**  
| A computer program for the analysis of isolated traffic signals developed by the TRL  
| **overlap**  
| Phases which run in successive stages (eg late start, early cut-off)  
| **oversaturation**  
| A traffic condition at traffic signals where demand exceeds capacity  
| **parallel stage streams**  
| Two or more complete sequences of stages within the same controller which operate at the same time enabling two junctions or parts of a junction to be controlled with or without interaction between them.  
| **period**  
| A time period in a phase during which there is no change in condition  
| **phase**  
| “Sequence of conditions applied to one or more streams of traffic which, during the cycle, receive simultaneous identical signal indications” (TP56) “Set of conditions that fixes the pattern of movement and waiting for one or more traffic streams during the signalling cycle.” (BS 6100 241 7509) By extension, the equipment within a controller which controls a phase.  
| **phase diagram**  
| A diagram showing (as horizontal lines) the sequence of conditions of each of the phases at a traffic signal junction  
| **plan selection**  
| A strategy for the control of a network of traffic signals where timings are selected from a library of pre-calculated plans according to traffic conditions  
| **presence**  
| A target being present within the detection zone  
| **pre-signal**  
| A traffic signal installed in advance of a junction to control access to the junction for a particular movement or type of vehicle in a segregated lane
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<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>protected movement</td>
<td>A signalled movement (commonly a right turn) where conflicting movements are held against a red signal</td>
<td>secondary signal</td>
<td>A signal beyond the stop line which duplicates the display at the primary signal</td>
</tr>
<tr>
<td>red</td>
<td>The colour of the aspect giving the instruction to stop</td>
<td>serve</td>
<td>A demand is said to be &quot;served&quot; when the phase to which it relates receives right of way</td>
</tr>
<tr>
<td>red/amber</td>
<td>The combination of aspects appearing before green</td>
<td>shadow</td>
<td>A gap in traffic downstream of a traffic signal caused by the changing of the signals</td>
</tr>
<tr>
<td>relative offset</td>
<td>The offset between one signalled junction and another</td>
<td>shuttle working</td>
<td>A system where signals are used to control a one way section of carriageway operating in alternating directions</td>
</tr>
<tr>
<td>reserve capacity</td>
<td>The difference between the capacity of a junction and the current demand (usually expressed as a percentage of the current demand)</td>
<td>signal</td>
<td>A dynamic indication presented to road users</td>
</tr>
<tr>
<td>right of way (at traffic signals)</td>
<td>Right of priority attached to traffic moving in a particular direction or a priority temporarily given to traffic by signals, signs pedestrian crossings or other means. (see “right of way (general)”)</td>
<td>split</td>
<td>The division of available green time within a signal cycle between stages</td>
</tr>
<tr>
<td>run</td>
<td>A phase is said to be running when it is displaying a green signal. A stage is said to run a phase if that phase displays a green signal during that stage.</td>
<td>stage</td>
<td>Indication by traffic signals during a period of the signalling cycle that gives right of way to one or more particular traffic movements. A stage starts when the last of its associated phases commences and ends when the first of its associated phases terminates.</td>
</tr>
<tr>
<td>saturation flow</td>
<td>The maximum flow (usually expressed in pcu or vehicles per hour) obtained at a stop line during green from a discharging queue</td>
<td>stage diagram</td>
<td>A diagram for a signalled controlled junction showing by means of arrows those movements permitted in each of the stages</td>
</tr>
<tr>
<td>SCOOT</td>
<td>Split, Cycle, Offset Optimisation Technique which uses real time traffic data to minimise stops and delays for UTC controlled areas.</td>
<td>starting delay</td>
<td>The time interval between the start of actual green and the start of effective green</td>
</tr>
<tr>
<td></td>
<td></td>
<td>storage</td>
<td>Ability for vehicles (usually right turning) to wait within the junction</td>
</tr>
<tr>
<td><strong>TRANSYT</strong></td>
<td>An off-line program for predicting the performance of a network of traffic signals with a given set of traffic flows and signal timings. In conjunction with its in-built optimiser, it is used to calculate the optimum set of timings for a given set of traffic flows. (TRAffic Network StudY Tool)</td>
<td></td>
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<tr>
<td><strong>UTC</strong></td>
<td>Urban Traffic Control. A method of controlling and managing a number of traffic signals from one computer system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>variable maximum green</strong></td>
<td>A feature of vehicle actuated control which allows the maximum green timing to be varied according to traffic flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>variable minimum green</strong></td>
<td>A feature of vehicle actuated control which allows the minimum green timing to be varied according to traffic flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>vehicle actuation</strong></td>
<td>Traffic signalling strategy in which the duration of the red and green signals and the time of duration of the cycle vary in relation to the traffic flow into and through the controlled area. It is actuated by the traffic by means of vehicle detection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Webster</strong></td>
<td>A method of calculating traffic signal timings developed by F V Webster and published in “Traffic Signals” (RRL Technical Paper 56 by F V Webster and B M Cobbe) 1966.</td>
<td></td>
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<tr>
<td><strong>y value</strong></td>
<td>The ratio of demand and saturation flow for a traffic stream</td>
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<tr>
<td><strong>Y</strong></td>
<td>The sum of the y values of the critical traffic stream of each stage for all the stages in the cycle</td>
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<tr>
<td><strong>yellow</strong></td>
<td>See “amber”</td>
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</tbody>
</table>

**Equipment terms**

<p>| term | definition |
| aspect (signal aspect) | A single optical unit which, when illuminated, displays a single colour or symbol. |
| <strong>audible signal</strong> | A device producing a sound to indicate right of way to pedestrians |
| <strong>backing board</strong> | A board mounted behind or around a signal head to increase contrast and improve visibility (referred to as “background screen” in BS EN specifications). |
| <strong>bleep and sweep</strong> | A distinctive audible signal system designed to give clear directional clues over a restricted distance for use at closely spaced pedestrian crossings where it is important not to give a misleading indication. |
| <strong>bleeper</strong> | A device for producing an audible signal |
| <strong>box sign</strong> | A regulatory sign (such as a prohibited movement sign) designed to be mounted alongside a signal head |
| <strong>bracket</strong> | A device for mounting a signal head on to a signal pole |
| <strong>cabinet</strong> | A box installed on-street to contain a controller or other equipment |</p>
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<tr>
<th>Term</th>
<th>Definition</th>
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<tr>
<td>cabling</td>
<td>The wiring installed on-street to connect a traffic signal controller with the signal aspects and other equipment</td>
<td>guard railing</td>
<td>Railing installed on footways and islands to direct pedestrians to the correct crossing points</td>
</tr>
<tr>
<td>CLF</td>
<td>A system for co-ordinating the timings of signal equipment at adjacent signalled junctions by the use of clocks synchronised to mains supply frequency. (Cableless Linking Facility)</td>
<td>hood</td>
<td>see “visor”</td>
</tr>
<tr>
<td>configurator</td>
<td>A software based device for preparing the programming for microprocessor based traffic signal controllers</td>
<td>housing</td>
<td>see &quot;cabinet&quot;</td>
</tr>
<tr>
<td>controller</td>
<td>Apparatus that controls and switches traffic signals.</td>
<td>lamp</td>
<td>The light source in a signal aspect</td>
</tr>
<tr>
<td>detector</td>
<td>Unit of the vehicular or pedestrian detecting equipment that initiates a demand or extension.</td>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>detector loop</td>
<td>One or more turns of wire installed in the road surface forming part of a vehicle detector which relies on the electromagnetic changes caused by a vehicle</td>
<td>loop detector</td>
<td>A detector which operates by analysing the electromagnetic effects on a buried loop of wire caused by the presence or passage of a vehicle.</td>
</tr>
<tr>
<td>detector unit</td>
<td>The part of the detector which is connected to a detector loop or transducer and produces an output when a vehicle is detected</td>
<td>loop feeder</td>
<td>Cable connecting a detector loop to its detector unit</td>
</tr>
<tr>
<td>detector unit</td>
<td></td>
<td>loop tails</td>
<td>The straight ends of the wire forming a loop which are connected to the loop feeder</td>
</tr>
<tr>
<td>detector</td>
<td></td>
<td>mast arm</td>
<td>A pole being curved or having a cantilevered branch to allow a sign or signal to be mounted above a carriageway</td>
</tr>
<tr>
<td>duct box</td>
<td>A chamber installed in the ground which gives access to cable ducts</td>
<td>optical unit</td>
<td>The optical components (lens, lamp, reflector, housing) making a single signal aspect.</td>
</tr>
<tr>
<td>ducting</td>
<td>The system of ducts carrying the cabling at a junction</td>
<td>pole box</td>
<td>A box installed in the ground at the base of a signal pole to give access to cabling</td>
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<tr>
<td>gantry</td>
<td>A frame in the shape of a portal used to mount signs or signals</td>
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<td>Term</td>
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<tr>
<td>portable signal</td>
<td>A traffic signal designed to be moved from place to place</td>
<td>solar cell</td>
<td>A light sensitive device mounted on signals to initiate dimming of the lamps during darkness</td>
</tr>
<tr>
<td>PROM</td>
<td>Programmable Read Only Memory</td>
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<tr>
<td>push button</td>
<td>A button which may be pressed to register a demand</td>
<td>solid state relay</td>
<td>A device having the isolated switching functions of a relay achieved by the use of solid-state electronics rather than solenoids and physical switching contacts</td>
</tr>
<tr>
<td>push button box</td>
<td>A housing containing a push button. Also “push button unit”</td>
<td>stool</td>
<td>A framework installed below ground on to which a housing is mounted</td>
</tr>
<tr>
<td>reflector</td>
<td>A curved polished device mounted behind a lamp to focus the light through the lens</td>
<td>stud</td>
<td>A square or circular metallic or thermoplastic marker installed on a road surface to indicate the line of a pedestrian crossing</td>
</tr>
<tr>
<td>regulatory sign</td>
<td>A sign indicating a traffic regulation (such as a prohibited movement)</td>
<td>SVD</td>
<td>A detector which responds only to certain vehicles identified by their characteristics or by an electronic tag. (Selective Vehicle Detector)</td>
</tr>
<tr>
<td>relay</td>
<td>An electrical switch using a coil and solenoid which makes or breaks contacts when the coil is energised. Other types of equipment having the same function</td>
<td>tactile indicator</td>
<td>An indicator (typically a rotating cone) which indicates the presence of a green signal for the benefit of visually impaired pedestrians</td>
</tr>
<tr>
<td>SA</td>
<td>Speed Assessment. A VA control strategy for high speed roads which affects the changing of the signals according to the speed of approaching vehicles</td>
<td>tactile paving</td>
<td>A type of textured paving which can be identified by visually impaired pedestrians to indicate the location of a pedestrian crossing facility</td>
</tr>
<tr>
<td>SDE</td>
<td>Speed Discrimination Equipment. A VA control strategy for high speed roads which discriminates vehicles travelling above a give speed threshold</td>
<td>temporary signal</td>
<td>A traffic signal using the same type of signal equipment as permanent signals but which is installed for a limited period of time (e.g. signals in barrels)</td>
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<tr>
<td>segmented arrow</td>
<td>An arrow signal where the head and shaft of the arrow are separated to improve legibility of the arrow direction</td>
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<td>signal pole</td>
<td>A pole installed at a traffic signal installation to</td>
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<tr>
<td>Term</td>
<td>Definition</td>
<td>Annex A Glossary</td>
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<tr>
<td>terminal</td>
<td>A device which can be connected to a controller (or other equipment) to allow information to be input or extracted</td>
<td>central reserve A central island separating the two halves of a dual carriageway</td>
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</tr>
<tr>
<td>tram signal</td>
<td>A signal which controls Light Rail Vehicles running on-street at signalled junctions</td>
<td>cycle lane Part of the carriageway indicated by road markings that is reserved for cyclists. Cycle lanes may be “Mandatory” or “Advisory” in their legal status as to the exclusion of non-cycle traffic.</td>
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<tr>
<td>variable message sign</td>
<td>A sign with a legend which can be varied</td>
<td>cycle track A way constituted or comprised in a highway being a way over which the public have right of way on pedal cycles only, with or without the right of way on foot.</td>
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</tr>
<tr>
<td>visor</td>
<td>A device mounted above a signal aspect to prevent incident light falling on the lens and reducing contrast and/or to prevent the aspect being seen by road users for whom it was not intended (also hood)</td>
<td>flare The local widening of an approach close to the junction</td>
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<tr>
<td>wait indicator</td>
<td>An illuminated panel in a pedestrian push button box which indicates that a demand has been registered</td>
<td>footway A way comprised in a highway which also comprises a carriageway over which the public has a right of way on foot</td>
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</tr>
<tr>
<td>wig wag</td>
<td>A signal having two similar aspects which are illuminated alternately.</td>
<td>footpath A way over which the public have a right of way on foot only, not being a footway</td>
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<td>high speed road A road where the 85th percentile approach speeds at a junction are 35mph (56km/h) or above.</td>
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<td><strong>Highway terms</strong></td>
<td>highway Way over which the public has right to pass. The right may be restricted to specific classes of vehicle</td>
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<tr>
<td>term</td>
<td><strong>definition</strong></td>
<td>island Raised area on the highway, usually at a road junction, shaped and located so as to direct traffic movement</td>
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<tr>
<td>all-purpose road</td>
<td>Road for the use of all classes of traffic.</td>
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<td>approach</td>
<td>That part of an arm which carries traffic towards the junction</td>
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<tr>
<td>arm</td>
<td>One of the highways radiating from a junction</td>
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<tr>
<td>carriageway</td>
<td>That part of a road or highway constructed for the use of vehicular traffic</td>
<td>lane A section of an approach marked for the use of a single file of vehicles</td>
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<tr>
<td>Term</td>
<td>Definition</td>
<td>Operation Terms</td>
<td>Definition</td>
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<tr>
<td>motorway</td>
<td>Limited access dual carriageway road not crossed on the same level by other traffic lanes for the exclusive use of certain classes of motor vehicles.</td>
<td>bus priority</td>
<td>A strategy for reducing delay to buses</td>
</tr>
<tr>
<td>pocket</td>
<td>A short additional lane on an approach or within a junction reserved for a specific movement</td>
<td>capacity</td>
<td>The maximum flow that can proceed through a certain point in a given period of time</td>
</tr>
<tr>
<td>refuge</td>
<td>A island where pedestrians may wait.</td>
<td>dimming</td>
<td>The reduction in brightness of signal aspects during hours of darkness to reduce glare to road users</td>
</tr>
<tr>
<td>right of way</td>
<td>Right of passage for the public or class of road user (such as footways or cycle tracks). See “right of way (at traffic signals)”</td>
<td>duplicate primary signal</td>
<td>A second primary signal mounted on the right hand side of the carriageway</td>
</tr>
<tr>
<td>(general)</td>
<td></td>
<td>fall back</td>
<td>The control strategy adopted by a control system when the preferred strategy becomes faulty</td>
</tr>
<tr>
<td>road</td>
<td>Any highway and any other road to which the public has access and includes bridges over which a road passes. (In Scotland the definition of “road” includes any way over which the public have a right of passage. (See “highway”).)</td>
<td>filter arrow</td>
<td>A green arrow which appears with a red (or amber or red/amber) signal to give right of way to a specific movement</td>
</tr>
<tr>
<td>stop line</td>
<td>A line on an approach indicating where vehicles should stop</td>
<td>flashing</td>
<td>Intermittent operation of a signal aspect</td>
</tr>
<tr>
<td>trunk road</td>
<td>A road of national importance administered by central government</td>
<td>group timer</td>
<td>A device controlling the time periods for a signal group</td>
</tr>
<tr>
<td>indicative green arrow</td>
<td>A green arrow indicating that vehicles may proceed in the direction shown which is also covered by a full green signal. Opposing traffic has been stopped.</td>
<td>lamp monitoring</td>
<td>A system of checking within a controller that lamps are operating</td>
</tr>
<tr>
<td>blackout</td>
<td>A period in a pedestrian sequence when neither the red nor the green man symbol is illuminated</td>
<td>national sequence</td>
<td>The sequence of indications of traffic signals which are prescribed by national legislation or regulation</td>
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<td>Term</td>
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<tr>
<td>phantom</td>
<td>A false impression that an aspect is illuminated caused by incident light being internally reflected back through the lens</td>
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<tr>
<td>primary signal</td>
<td>A signal head close to the stop line normally mounted on the left hand side of the carriageway</td>
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<td>red lamp monitoring</td>
<td>Lamp monitoring of some or all of the red lamps at a junction</td>
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<td>remote monitoring</td>
<td>A system installed at a signal controller which checks for faults in operation and reports them automatically to a central point</td>
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<tr>
<td>road</td>
<td>Surfaced way mainly for vehicles</td>
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<td>secondary signal</td>
<td>A signal head beyond the stop line supplementing the primary signal</td>
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<td>signal display</td>
<td>The combination of illuminated aspects in a signal head which provides a control instruction to traffic.</td>
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<td>signal face</td>
<td>One or more signal heads mounted together turned towards a traffic stream</td>
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<tr>
<td>signal group</td>
<td>A group of signal heads controlled by the same phase</td>
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<tr>
<td>signal head</td>
<td>A combination of signal aspects which together provide all the signal displays required for the control of one or more traffic streams at the same stop line.</td>
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<tr>
<td>signal plan</td>
<td>A set of timings for the control of a groups or network of junctions</td>
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<td>signal sequence</td>
<td>The sequence of displays shown by a signal head</td>
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<td>signals off</td>
<td>A condition of the signals where all signal lamps are switched off</td>
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<td>start up sequence</td>
<td>The controlled order through which signals progress from the off/standby mode to normal operation.</td>
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<tr>
<td>stream (traffic stream)</td>
<td>Vehicles in one or more lanes on the same approach to the controlled area which, when they have the right–of–way, will move in the same direction.</td>
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<tr>
<td>time table</td>
<td>In a coordinated traffic signal, system a list of times and days when control events (such as plan changes) take place</td>
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<tr>
<td>walk with traffic</td>
<td>A control system where pedestrian phases run with non-conflicting vehicle phases</td>
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<tr>
<td>washout</td>
<td>The reduced contrast between an illuminated aspect and its background caused by the non-specular reflection of incident light on the lens</td>
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<tr>
<td>absolute offset</td>
<td>The offset between a signalled junction and a common reference for a controlled area</td>
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<tr>
<td>classified count</td>
<td>A count were flows for different classes of vehicle are recorded separately</td>
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<tr>
<td>count</td>
<td>An enumeration of vehicles at a point over a specific time period</td>
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Traffic Engineering terms

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<th>Term</th>
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<tbody>
<tr>
<td>flow</td>
<td>The rate of passing of vehicles at a point (expressed in pcu or vehicles per hour).</td>
<td>platoon</td>
<td>A group of vehicles moving together where the behaviour of each vehicle is influenced by the vehicle in front.</td>
</tr>
<tr>
<td>gap</td>
<td>The difference in time or space between the back of a vehicle and the front of the following vehicle</td>
<td>platoon dispersion</td>
<td>The tendency for platoons to extend and break up under free running conditions.</td>
</tr>
<tr>
<td>headway</td>
<td>The difference in time or space between the front of a vehicle and the front of the following vehicle</td>
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<tr>
<td>junction</td>
<td>The meeting point between two or more roads (Note: no distinction is usually made between a junction being where roads meet and an intersection being where roads cross)</td>
<td>puffin crossing</td>
<td>A pedestrian crossing that uses near–side pedestrian signals heads and an extendable All–Red crossing period which is instigated by a push button request accompanied by a pedestrian detector demand. (from Pedestrian User Friendly INtelligent crossing.)</td>
</tr>
<tr>
<td>link</td>
<td>In a network, a connection between nodes. In traffic networks links between junctions may be defined for particular directions, movements or vehicle types.</td>
<td>queue</td>
<td>A stationary or slow moving file of traffic where the progress of a vehicle is determined by that of the preceding vehicle.</td>
</tr>
<tr>
<td>movement</td>
<td>The traffic taking a specific route through a junction from a defined entry to a defined exit.</td>
<td>RFC</td>
<td>A measure of level of use (Ratio of Flow to Capacity)</td>
</tr>
<tr>
<td>node</td>
<td>In a traffic network, a junction or other point where it is convenient to identify as the end of a link</td>
<td>road marking</td>
<td>Line, symbol or other mark on a road surface to regulate, warn, guide or inform road users.</td>
</tr>
<tr>
<td>occupancy</td>
<td>The proportion of time during which a vehicle is determined to be present.</td>
<td>time-distance diagram</td>
<td>A diagram for a linear system of traffic signals showing the signalled junctions' locations on the &quot;distance&quot; axis and the main road signal sequences of the &quot;time&quot; axis. This can be used to design and examine &quot;green wave&quot; timings</td>
</tr>
<tr>
<td>pcu</td>
<td>The basic unit of traffic flow equal to the equivalent of a typical car (passenger car unit).</td>
<td>toucan crossing</td>
<td>A stand–alone combined pedestrian/ cyclist crossing.</td>
</tr>
<tr>
<td>pelican crossing</td>
<td>A pedestrian crossing using far-side pedestrian indicators with a flashing amber/flashing green man period where vehicles are permitted to move subject</td>
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</tbody>
</table>