CORRECTIONS WITHIN DESIGN MANUAL FOR ROADS AND BRIDGES
FEBRUARY 2007

SUMMARY OF CORRECTION – TA 84/06 Volume 8, Section 1, Part 2 CODE OF PRACTICE FOR TRAFFIC CONTROL AND INFORMATION SYSTEMS FOR ALL-PURPOSE ROADS

Corrections have been made to Chapter 8 – reference to 'MCH 1869' changed to 'MCH 1969'.

We apologise for the inconvenience caused.

Highways Agency
February 2007

London: The Stationery Office

VOLUME 8 TRAFFIC SIGNS AND LIGHTING
SECTION 1 TRAFFIC SIGNALS AND CONTROL EQUIPMENT

PART 2

TA 84/06

CODE OF PRACTICE FOR TRAFFIC CONTROL AND INFORMATION SYSTEMS FOR ALL-PURPOSE ROADS

SUMMARY

This Advice Note is a primary reference document drawing attention to statutory requirements, relevant standards and advice notes contained in existing documentation and provides general information on good practice not fully covered in other documents. This document also offers guidance through defining new practice and procedures associated with the safety aspects of a scheme and by reflecting good practice and principles that have been established by UK practitioners over the years. This document replaces TA 84/01 and MCH 1813.

INSTRUCTIONS FOR USE

1. Remove Contents pages from Volume 8 and insert new Contents pages for Volume 8 dated May 2006.

2. Remove TA 84/01 from Volume 8, Section 1 which is superseded by this Standard and archive as appropriate.

3. Insert TA 84/06 into Volume 8, Section 1.

4. Please archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from The Stationery Office Ltd.

THE HIGHWAYS AGENCY

TRANSPORT SCOTLAND

WELSH ASSEMBLY GOVERNMENT
LLYWODRAETH CYNULLIAD CYMRU

THE DEPARTMENT FOR REGIONAL DEVELOPMENT
NORTHERN IRELAND

Code of Practice for Traffic Control and Information Systems for All-Purpose Roads

Summary: This Advice Note is a primary reference document drawing attention to statutory requirements, relevant standards and advice notes contained in existing documentation and provides general information on good practice not fully covered in other documents. This document also offers guidance through defining new practice and procedures associated with the safety aspects of a scheme and by reflecting good practice and principles that have been established by UK practitioners over the years. This document replaces TA 84/01 and MCH 1813.

REGISTRATION OF AMENDMENTS

Amend No	Page No	Signature & Date of incorporation of amendments	Amend No	Page No	Signature & Date of incorporation of amendments
Correction No 1	**8/1 – 8/2**	**February 2007**			

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OVERVIEW

This Code of Practice has been produced to assist highway and road authorities, consultants and contractors who design and implement traffic control and information systems. This document is advisory, containing recommendations to assist in the promotion of safety and consistency of good design practice. The Code covers conventional traffic signalling systems, signalled controlled crossings and innovative systems incorporating driver information.

This Code of Practice includes a self-certification procedure under which highway authorities may certify that they comply with the Code, refers to existing departmental legislation and advice and describes procedures that have been established for many years. It introduces methodologies, which will be new to many organisations, such as the whole life cycle approach to systems design.

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CODE OF PRACTICE FOR TRAFFIC CONTROL AND INFORMATION SYSTEMS FOR ALL-PURPOSE ROADS

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1. INTRODUCTION

1.1 General

1.1.1 Systems for controlling traffic or providing information to drivers are growing in complexity, and the range of solutions available is getting wider. It is important that safety for the users of the road network is assured by good practice, during all phases of the life cycle of these new intelligent transport systems. The Department for Transport (the Department) already provides some aspects of good practice, together with legislation and guidance. Other sources of advice are available both in the UK and Europe, but there was no single source covering the issues addressed in this Code of Practice.

1.1.2 This Code of Practice recommends and makes reference to good practice to be adopted for all traffic control or information systems, both simple and complex, and during all stages of the life cycle from design and installation, through maintenance and operation to eventual decommissioning of the system.

1.1.3 The document MCH 1969 'Traffic Control System Design for All-Purpose Roads (Compendium of Examples) (Ref. Section 7.2)' is intended to assist designers of traffic control and information systems by presenting examples that illustrate good practice.

1.1.4 The objective of this Code of Practice is to promote safety and effectiveness through good practice and procedures, and to foster awareness when designing to give good value for money, of costs incurred throughout the whole life cycle of the system. A further function is to form a central reference, guiding users to other relevant Department publications that contain advice on the design, maintenance and operation of systems.

1.1.5 This Code of Practice is aimed at a wide variety of technical personnel engaged in the design and implementation of systems, primarily:

- scheme designers in highway authorities and consultancies;
- supervisors of installation and commissioning of works;
- staff responsible for maintenance and operation of systems; and
- equipment manufacturers.

1.2 Scope

1.2.1 This Code of Practice applies to roadside systems that convey instructions or information to the road user through signal control, variable signs or symbols. Such systems will incorporate a control system, which will be electrical, electronic or electro-mechanical. Purely mechanical systems are excluded.

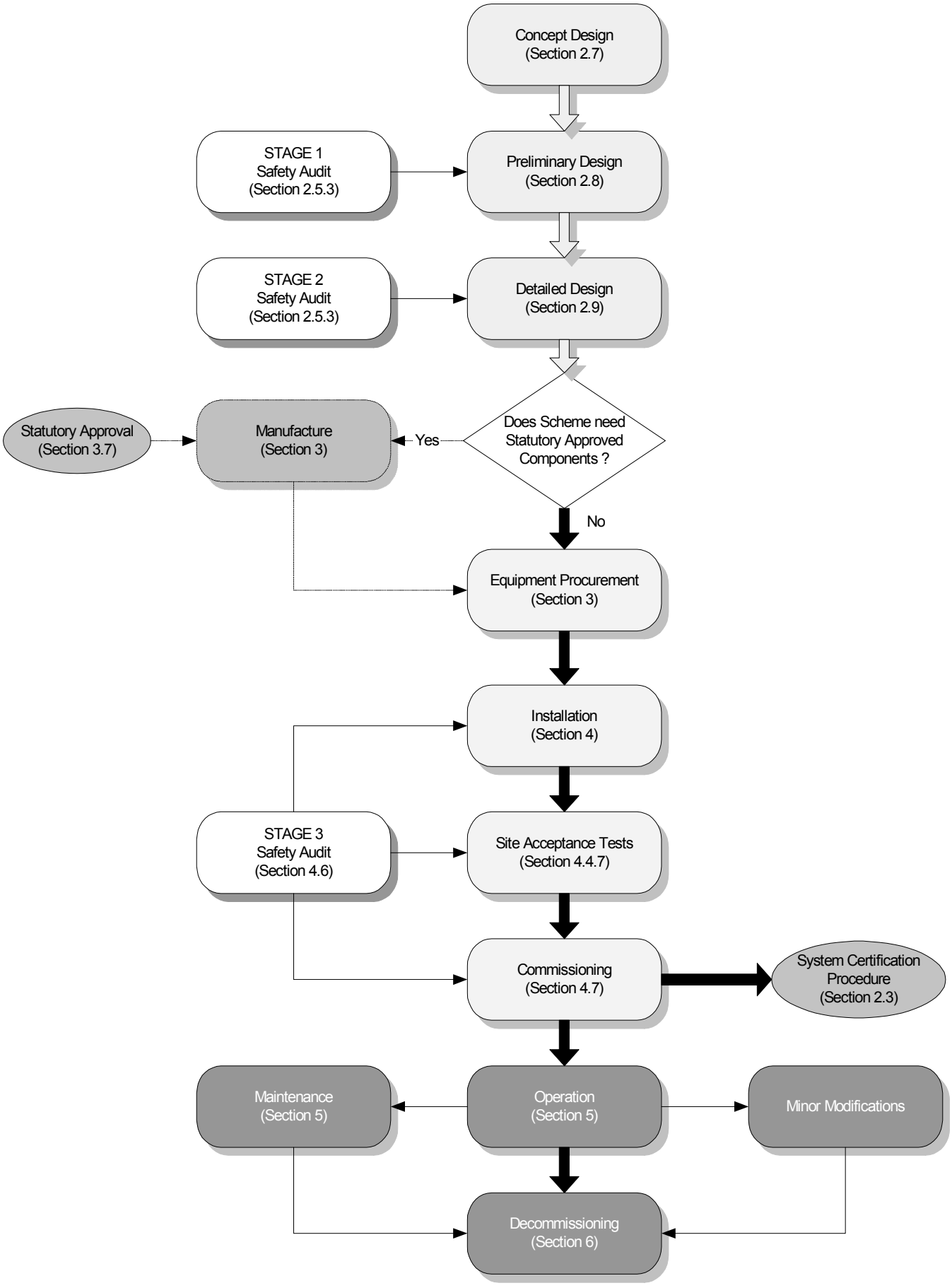
1.2.2 This Code of Practice covers all-purpose public roads operated by highways authorities ('road' authorities in Scotland) except motorways in the UK.

1.2.3 This Code of Practice deals with systems which themselves form part of traffic schemes. In developing a safe design, a system cannot be considered in isolation but must be viewed in its scheme context. This Code of Practice is therefore concerned with detailed traffic engineering and control aspects of the system including:

- the layout, which provides the context for the control or information system;
- the method of control; and
- maintenance.

1.2.4 While the aim of this Code of Practice is to pursue safety and effectiveness throughout the whole life cycle of the system, the recommendations it gives concern activities undertaken during the design and implementation stages only. These include the establishment of a maintenance regime designed to preserve the safety of the system after commissioning. Safety is then controlled without further reference to this Code of Practice, through procedures defined in maintenance specifications and routines that the designer has ensured are appropriate for the continued safe operation of the system.

1.2.5 A proposal to modify the system should be treated in the same way as a new system, and hence the designers and manufacturers of the modification should follow this Code of Practice.


Concept Design
(Section 2.7)
STAGE 1
Safety Audit
(Section 2.5.3)
Preliminary Design
(Section 2.8)
STAGE 2
Safety Audit
(Section 2.5.3)
Detailed Design
(Section 2.9)
Statutory Approval
(Section 3.7)
Manufacture
(Section 3)
Yes
Does Scheme need
Statutory Approved
Components ?
No
Equipment Procurement
(Section 3)
Installation
(Section 4)
STAGE 3
Safety Audit
(Section 4.6)
Site Acceptance Tests
(Section 4.4.7)
Commissioning
(Section 4.7)
System Certification
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(Section 2.3)
Maintenance
(Section 5)
Operation
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Minor Modifications
Decommissioning
(Section 6)

1.2.6 This Code of Practice also refers to considerations that may become important when the system is decommissioned.

1.3 System Certification

1.3.1 A formal process for certifying that procedures contained in this Code of Practice, have been followed for any particular system is System Certification. The procedure and forms are set out at Appendix C.

1.3.2 This Code of Practice has the status of an Advice Note, and System Certification is not a statutory requirement for new systems. However, the completion of a System Certificate, such as the carrying out of a Road Safety Audit, provides a discipline for scheme designers. At the same time, it is a positive way of demonstrating that safety has been considered at all stages of the design and implementation process. This could be needed if the safety of the system after commissioning is ever called into question.

1.3.3 Using this Code of Practice as a guide to good practice when preparing a system design does not necessarily imply that the system must proceed to full System Certification. Generally, any system that forms part of a traffic scheme, which undergoes a Road Safety Audit, is a candidate for System Certification. However, it is for the organisation responsible for the system to decide whether System Certification is appropriate or not. If it is decided that System Certification will be pursued, there are parts of the Code of Practice that are essential to certification which must be followed before a certificate can be issued.

1.3.4 This Code of Practice therefore has two distinct applications:

- It can be used as a general guide to good practice, in which case all its requirements are advisory.
- Alternatively, it can be used as a process for System Certification, in which case some of its processes are mandatory in the sense that they are fundamental to the certification process.

1.3.5 The System Certification approach is the one that should be adopted for all-purpose trunk road schemes, unless otherwise directed by the Overseeing Organisation. The requirements for System Certification are dealt with in more detail in Appendix C.

1.3.6 It is recommended that organisations formally record their implementation method, for both this Code of Practice and System Certification. System designers can then use this methodology to help them follow the process. It will also be helpful in demonstrating that the process has been properly considered, if it is questioned or audited at a later date.

1.4 Document Structure

This Code of Practice includes five further chapters dealing with scheme development:

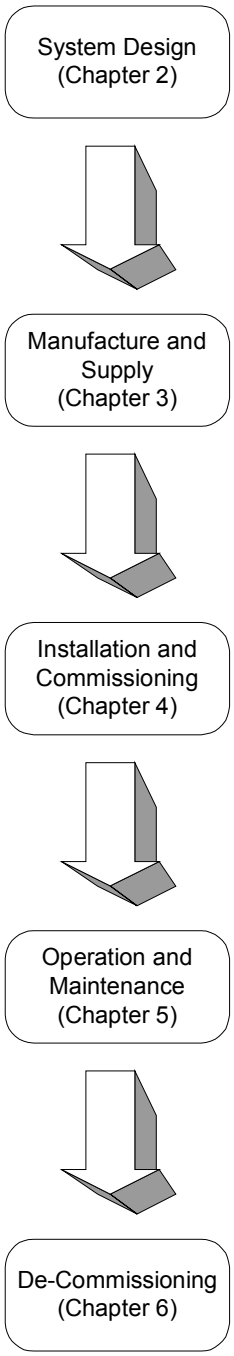

Figure 1-1 Document Structure

- Chapter 2, Design, describes general and statutory requirements for system designers and system design documentation. The principles of safety assessment and life cycle costing applied to traffic control and information systems are considered, and procedures for design from concept through to detail are described.

- Chapter 3 describes good practice for the manufacture and supply of products used in traffic control and information systems.

- Chapter 4 concerns procedures for installation, testing and commissioning systems.

- Chapter 5 recommends good practice to be adopted in setting up and managing procedures for operation and maintenance with reference to existing Department standards.

- Chapter 6 deals with the issues arising from decommissioning a system.

1.5 Implementation

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

1.5.2 The use of this Code of Practice is strongly recommended for all traffic control and information systems and schemes on all-purpose trunk roads.

2. SYSTEM DESIGN

2.1 Requirements for System Designers

2.1.1 Organisation

2.1.1.1 Although not an essential requirement, it is recommended that design organisations should operate a Quality Assurance Scheme such as a scheme registered with a UKAS accredited body under ISO 9001 (Quality Assurance) or the European equivalent for the design of traffic control and information systems.

2.1.1.2 When entering into a contract for the design of a traffic control system, the Client should ensure (through a carefully managed pre-selection process) that only competent organisations are invited to tender.

2.1.2 Qualifications

2.1.2.1 The design of traffic control systems is a specialist activity. Although there is no specific qualification that ensures competence in this field, those involved in traffic control design should have an appropriate understanding of the engineering issues and experience of traffic control work.

2.1.2.2 Although numerous documents (including this Code of Practice) are available which give guidance on the design of systems, particularly the standard ones, because traffic control systems have wide implications for safety and the environment, it is essential that a competent and experienced engineer supervises the design process.

2.1.2.3 In assessing the competence of staff or organisation responsible for design, the following may reasonably be considered:

- membership of a relevant professional body;
- familiarity with design of similar systems and the health and safety aspects concerned with them;
- the technical facilities and resources available to the designer or design organisation.

2.1.2.4 Overseeing Organisations may wish to develop a formal methodology for assessing the competency of design staff, to which evidence of competency would refer.

2.1.2.5 Evidence of competence of those responsible for the design of a system should be included in the Design File. Design organisations can maintain lists of competent staff that can be referred to in the Design File. Alternatively, the Design File can include a brief description of the individuals involved in the design process. This may be an appropriate method where designs are carried out by external consultants.

2.2 Documentation

2.2.1 Design File

2.2.1.1 Each scheme or system should be developed using a ‘Design File’ as a link between the individual stages of the whole life cycle. This file has some overlap with the requirements of the Health and Safety File defined in the ‘Construction (Design and Management) Regulations’ and the ‘Construction (Design and Management) NI Regulations’.

2.2.1.2 The purpose of the Design File is to provide a record of the development of the system in its scheme context, the decisions made and, in particular, the safety considerations. It provides information to manufacturers and installers and, following commissioning, becomes an historic reference file for the project.

2.2.1.3 The Design File should include the following information:

- Preliminary Design Brief (Section 2.7.3);
- Safety Case (including Risk Assessments) (Section 2.5.1);
- Output from safety review of Preliminary Design and Detailed Design including Stage 1, 2 and 3 Road Safety Audits;
- Detailed Design Brief (Section 2.9);
- System Requirements Specification (Section 2.9.3);
- Design change control documentation;
- System Certification;

- Names, qualifications and experience of the designers identified as being involved in the design of the system;
- Test documentation;
- As-built drawings and specification; and
- As-installed configuration data.

2.2.1.4 Individuals or organisations charged with tasks at any stage in the system life cycle must ensure that the Design File is available to them before work on the task is permitted. As well as being important in terms of ensuring that all design tasks are correctly carried out, this approach will help ensure that abortive work is minimised.

2.2.1.5 Any changes to designs or specifications should be introduced in accordance with an agreed change control procedure to ensure such changes are communicated to all others involved in the development of the system and its scheme context. The Design File will include details of design changes and how these were introduced.

2.2.1.6 The Design File should be retained to assist in the operation of the system, and to allow for the design process to be traced retrospectively, should a safety problem develop. Design material deemed relevant to the system as installed and commissioned should be held while the system remains in service, and for a minimum of six years from the date when the system is superseded.

2.2.1.7 There is no prescribed form that the Design File must take but there must be some physical entity that is identifiable as the Design File. As a minimum, it could be a list of documents with a reference to where each one is stored. It is not sufficient that all the documents required to make up the Design File are contained within a larger Project File unless the Design File components are specifically listed as such. It must be remembered that the Design File may be required for reference at any time during the life of a system and for some time after. It therefore will stay in existence for longer than many other archives. It must also be remembered that if the responsibility for a system changes, the Design File is to be passed to the organisation taking over responsibility. If, for convenience, documents are stored in different places, it must still be possible to construct a complete physical Design File at any time if required.

2.2.2 Other Documentation Requirements

2.2.2.1 Other documentation includes the requirements of:

- System Certification (Section 2.3);
- Quality Assurance (Section 1.1);
- System Requirements Specification (Section 2.9.3);
- The CDM Regulations (if they apply) (Section 2.5.4);
- Statutory Requirements (Section 4.2).

2.2.3 Statutory Regulations

2.2.3.1 All traffic control systems used on public roads must meet the requirements of any relevant statutory regulations. Those appropriate to schemes involving traffic signals and signs (including pedestrian signals) are contained in The Traffic Sign Regulations and General Directions 2002, The Traffic Signs Regulations (Northern Ireland), The Zebra, Pelican and Puffin Pedestrian Crossing Regulations and General Directions, The 'Zebra' Pedestrian Crossings Regulations (Northern Ireland) 1974 and The Traffic Signs (Welsh and English Language Provisions) Regulations and General Directions 1985.

2.2.3.2 It should be noted that traffic signal displays, road markings and variable message signs in legal terms are considered 'traffic signs' and are subject to The Traffic Signs Regulations and General Directions 2002.

2.2.4 Statutory Approval

2.2.4.1 (See Section 3.7)

2.2.5 Signs Authorisation

2.2.5.1 Symbols and legends which form part of a traffic control or information system and which are not prescribed within the regulations need specific authorisation by the Secretary of State, or in the case of Northern Ireland, the Department for Regional Development; for Wales, The Welsh Assembly Government and for Scotland, Scottish Executive.

2.2.5.2 The sign authorisation procedure involves the submission to the Department for Transport (for England, or other appropriate body for Northern

Ireland, Wales and Scotland) scale drawings of the sign face and a plan showing the intended location. Both the sign face and the location form part of the authorisation. Installation must be within the tolerance stated on the authorisation document. For signs, this is normally within five metres of the authorised location. For signal installations, the tolerance is normally two metres.

2.3 System Certification

2.3.1 System Certification is a procedure, the details of which are set out in Appendix C, for recording that the safety-related good practice recommended by this Code of Practice has been followed for any individual system. It is designed to ensure that records of safety analysis and reviews are held and can be audited, that the approval status is recorded, and that the organisation and individuals responsible for the different procedures are clearly documented.

2.3.2 Adopting the System Certification procedure will also provide a record that demonstrates compliance with the relevant Approving Authorities Approval requirements and aspects of the Health and Safety at Work etc. Act 1974 and the CDM Regulations.

2.3.3 The fundamental requirements of the process leading to System Certification are:

- procedures to ensure that safety aspects are fully considered;
- the documentation and traceability of all safety-related decisions;
- the independent checking of all designs;
- accountability and competence.

2.3.4 In order to achieve these requirements, the essential elements of this Code of Practice are:

- setting up and maintaining a Design File;
- carrying out Risk Assessments;
- developing a Safety Case;
- undertaking an independent system review;
- recording names and competence of personnel.

2.3.5 The System Certification procedure runs in parallel with this Code of Practice, and consequently may apply to any system that falls within the scope of this Code of Practice. The procedure starts at the preliminary design stage, and is completed at the time of commissioning of the system. For significant modifications, the procedure is restarted and operates in the same way as for a new system.

2.3.6 The procedure requires designers, manufacturers and installers of systems to retain specific items of documentation, and to record specified information, but does not attempt to standardise the format for the records, leaving this matter to the discretion of the organisations involved. Forms, which list items of documentation, information and stages in the development of the project, support the System Certification itself. Against each item, the information necessary to locate and audit the documentation has to be entered.

2.3.7 It is not an essential requirement for System Certification that design organisations operate a registered QA system, although it is a strong recommendation. Where a formal ISO 9000 Quality Assurance system is in operation, it is recommended that the System Certification procedure should be integrated within the QA procedures of designers, manufacturers and installers and subject to their own internal and external Quality Assurance audits.

2.4 Quality Assurance

2.4.1 The production of Quality Plans, archiving, quality and technical records, and the role of the Project Manager are requirements for all projects. The Quality Plan may simplify the standard procedures for smaller traffic control schemes.

2.4.2 Designers of traffic control systems should apply the requirements of HD 46, Quality Management Systems for Highway Design (DMRB 5.2.1), as many of the principles employed are similar to those for highway design.

2.5 Safety Assessment and CDM

2.5.1 Safety Case

2.5.1.1 The Safety Case is a logical argument supported by evidence to prove that the system in question has been developed to an acceptable level of safety. It describes the system and its boundaries, and identifies the hazards and risks indicating any safeguards provided. The Safety Case is concerned with both the system and the context in which it operates and

relates to the system throughout its life cycle. The basis of the Safety Case for a traffic control or information system should be a Risk Assessment prepared by the system designers.

2.5.1.2 In addition to the hazard list resulting from the Risk Assessment, the Safety Case should record:

- details of risk reduction measures employed;
- a description of the safety-related aspects of the control systems;
- evidence of the competence of personnel engaged in the design of the system.

2.5.2 Risk Assessments

2.5.2.1 The designer should prepare Risk Assessments for all aspects of the system and its physical and human context throughout the complete life cycle, from construction, installation and testing to operation, maintenance and eventual decommissioning. These Risk Assessments cover different aspects from those required under the CDM Regulations, which are primarily concerned with risks associated with, or brought about by, the physical construction of the site.

2.5.2.2 The preparation of Risk Assessments for common systems may be simplified by using checklists that identify the usual hazards, and measures to overcome them. When considering hazards in relation to construction or installation, liaison with the contractor may reveal information that could be helpful to designers.

2.5.2.3 The procedures for preparing a Risk Assessment start with drawing up a hazard list for the system in its scheme context. This is a list of elements or characteristics of the system that present particular risks. Hazards that are common to traffic control systems and which are already addressed by standards and specifications need not be included. For example, display of conflicting green indications, which is a potential hazard at all traffic signals, is already dealt with by the controller specification.

2.5.2.4 The hazard list should start with those hazards which are inherent to the site such as visibility, steep approaches, overhead or underground high voltage cables, the presence of vulnerable road users such as children, and disabled persons. It should go on to deal with potential hazards of the system itself, location and use of equipment and deal with any specific hazards of maintenance (such as servicing overhead equipment) and consequences of partial or total equipment failure.

2.5.2.5 Innovatory aspects of systems warrant special attention as they may present new risks that could require special counter measures. A feature of such systems is that they are likely to require special applications for specific approval from the relevant Approving Authority. It may be necessary to enlist the help of additional expertise to assess the risks involved and design the system to minimise their impact.

2.5.2.6 For each identified hazard, a note should be added detailing how the hazard is dealt with to minimise the associated risk and ensure that it is reduced to an acceptable level. What represents an ‘acceptable level’ of risk is largely subjective, but, as a guide, if the totality of risk associated with a system is higher than the ‘do nothing’ alternative, this is clearly unacceptable even though there may be other benefits, such as time savings, associated with it. Alternatively, a level of risk which is no more than is commonly experienced in similar highway environments can be argued as being ‘acceptable’.

2.5.2.7 It should be noted that hazards which have a very serious outcome but with a low level of risk of occurrence are generally less acceptable than hazards with a less severe outcome and a higher risk of occurrence even where the total risk (computed as likely outcome multiplied by the likelihood of occurrence) is the same.

2.5.2.8 The development of a Safety Case and the carrying out of Risk Assessments is an essential part of the System Certification procedure. For simpler, less complex schemes there may be few unusual hazards but a brief Safety Case should nevertheless be prepared to demonstrate that the hazards have been fully considered.

2.5.3 Road Safety Audits and reviews

2.5.3.1 The Road Safety Audit procedure is an independent review of a system design to ensure that all safety-related issues have been fully addressed and the implications considered throughout the design and implementation of the system.

2.5.3.2 The staff involved in a Road Safety Audit should be independent of the staff involved in the design. The Road Safety Audit team can be from an external organisation or made up from staff of the design organisation provided there are sufficient

competent staff independent of those involved in the design available to carry out the audit.

2.5.3.3 The Road Safety Audit procedure may be carried out as it would for any traffic engineering scheme provided the safety of the control and information system is reviewed either as part of an extended Road Safety Audit, or separately. The Road Safety Audit and the review of the control and information system make up the Safety Review (Section 2.9.5).

2.5.3.4 The Road Safety Audit is carried out in four stages:

- Stage 1: completion of preliminary design (before publication of draft orders);
- Stage 2: completion of detailed design (before commitment to the procurement process, e.g. invitation to tender);
- Stage 3: completion of construction (before opening);
- Stage 4: monitoring.

Stages 1 - 3 are relevant to this Code of Practice.

2.5.3.5 Where the scheme is of such a scale that no preliminary design is carried out, a combined Stage 1/2 Audit may be carried out (see HD 19).

2.5.3.6 When the review of the control and information system is incorporated in the Road Safety Audit rather than as a separate process, the audit team should include one or two people with experience of traffic control as well as road safety, or should appoint an appropriate Specialist Advisor (see HD 19). However, it should be realised that the Road Safety Audit process deals only with road safety. Issues of system security and safety will need to be dealt with separately.

2.5.3.7 Procedures for carrying out Road Safety Audits on Highway Schemes (the principles of which are equally applicable to traffic control schemes) are set out in HD 19 (DMRB 5.2.2).

2.5.4 Construction (Design and Management) Regulations

2.5.4.1 All construction projects are subject to the requirements of the CDM regulations with regard to the general duty of care for those responsible for design and construction. Projects which involve construction work lasting longer than 30 days or involving more than four people working on site at the same time have more specific requirements under the Regulations, including the appointment of a Planning Supervisor and the preparation of a Health and Safety Plan and a Health and Safety File. Many of the more complex traffic control systems will fall into this category. It is necessary to identify very early in the design process whether the specific CDM regulations will apply.

2.5.4.2 The purpose of the CDM regulations is to improve the overall management and coordination of health, safety and welfare throughout all stages of a construction project, from the construction phase through maintenance to the final decommissioning.

2.5.4.3 The regulations place duties on all those who can contribute to the health and safety of a construction project. Duties are placed upon clients, designers and contractors, and the regulations create a new duty holder – the Planning Supervisor. They also introduce two new documents – the Health and Safety Plan and the Health and Safety File.

2.5.4.4 The Planning Supervisor has the responsibility of co-ordinating the health and safety aspects of project design and planning and ensuring that the requirements of the Regulations are complied with, and that the health and safety plan and the health and safety file are prepared.

2.5.4.5 The Health and Safety Plan details all the health and safety-related issues regarding the construction of the project. Hazards and risks are noted and working methods to ensure safe construction identified. The Health and Safety Plan is first developed by the Planning Supervisor before the tender stage and then developed by the Contractor to take account of the work as carried out. It will identify significant hazards or work sequences that cannot be avoided or designed out and, where appropriate, a broad indication of the precautions assumed for dealing with them.

2.5.4.6 The Health and Safety File is a file which is handed over to the client following the construction phase and which will assist persons maintaining, modifying or decommissioning the equipment in future. There is no prescribed format for the file but it will include as-built drawings, design details, maintenance procedures and any manuals provided by suppliers.

2.5.5 Health and Safety at Work etc. Act

2.5.5.1 The Management of Health and Safety at Work Regulations also apply. These regulations make more explicit what is required by the Health and Safety at Work Act of employers. There is a requirement on employers to assess the risks to health and safety of their employees and other who may be affected by the work activity. In the context of a traffic control system, this would apply to maintenance procedures and the risks to health and safety which they bring to employees and members of the public. If a Health and Safety file is required for the project, any specific maintenance procedures that arise from the analysis of this Risk Assessment should be included in it.

2.6 Life Cycle Costing

2.6.1 Introduction

2.6.1.1 In examining the cost of a project, it is important that the total costs of the system over its lifetime are taken into consideration and not just the initial capital cost. The on-going costs of a traffic signal installation are very different from those of a roundabout that may represent an alternative solution. Life Cycle Costing is also necessary to compare systems involving different technologies where initial costs and running costs may follow different patterns.

2.6.1.2 The basis of Life Cycle Costing is to aggregate the costs of a system over its lifetime into a single sum. There are various methods of doing this but the method recommended here uses the same basis of analysis as the computer cost benefit analysis programme, COBA described in the Department's Design Manual for Roads and Bridges, Volume 13: Economic Assessment of Road Schemes.

2.6.1.3 In the analysis, all costs are expressed at base year prices. The base year can be the year the system is installed but this is not necessarily so. Any other year can be used provided where two systems are compared, the same base year is used in both. Where an annual cost (for example, maintenance) is expected to remain constant in real terms, the cost at base year prices will be the same for each year, even though the actual sums expended may rise with inflation. It is not therefore necessary to make any assumptions about future trends in inflation. If, however, it is expected that certain costs will rise in real terms (that is, will grow faster than the rate of overall inflation), the annual costs expressed at base year prices will also grow.

2.6.1.4 When the costs for each year of the life of the system (at base year prices) has been assessed, they can be combined to produce a Net Present Cost by discounting future costs back to the present day, or more accurately to the year in which the major initial expenditure on the project is made. (Note, the discounting is not back to the base year.) The principle of discounting is based on the fact that future costs are less onerous than present ones. At its simplest, on the assumption that it is possible to invest money at a rate of return higher than inflation, money invested now will grow in real terms by an annual percentage equal to the rate of interest received minus the rate of inflation. Consequently, the amount of money required now to be set aside to meet a future liability will be less than the liability itself.

2.6.1.5 The net interest rate used in the calculation is the Discount Rate. If a comparison is made between a present cost and a future cost funded by monies deposited now in an interest bearing account, the discount rate would be the difference between the rate of interest obtained and the rate of inflation, a net rate of about 2-3%. In practice, monies required later in a project would not be deposited but be considered as a reduction in current borrowing requirements representing a saving at the borrowing rate of interest that is higher than the investment rate. Accordingly, higher Discount Rates are used in practice. The Discount Rate advised by the Department for use in COBA is the appropriate one to use for life cycle costings of traffic control systems.

2.6.2 Factors to be considered in Life Cycle Costing

Life of Project

2.6.2.1 If the life of the project is known, or can be reasonably estimated, this should be used in the analysis. This will be appropriate where, for example, a traffic signal system is to be installed when it is known that a planned future road scheme will require its removal. Where the life of the system is indeterminate, as is the case with the majority of traffic control systems, it is reasonable to equate the life of the system with the economic life of its major components. A typical period which is consistent with data provided in the specification for traffic signal controllers (TR2210/ TR2500) would be fifteen years.

Initial Cost

2.6.2.2 An assessment of the initial cost will normally be at hand at the time a life cycle costing is

undertaken but it is important to ensure that all elements of the cost of implementing the system are included. In the case of a traffic signal installation these would include the costs of design, testing and commissioning, the cost of connecting to the mains power supply, and the cost of provision of a communication line, outstation transmission or monitoring unit, as well as the normal costs of equipment and its installation, including civil construction. In deciding whether an item should be included in the initial cost it is necessary to ask whether the money and resources (including staff time) associated with that item would be saved if the project were not proceeded with.

Maintenance

2.6.2.3 Wherever possible, the costs of maintenance used in the analysis should be based on actual costs incurred for the maintenance of similar systems in the area. Where there is no better estimate, a good rule of thumb is that the cost of maintenance of electronic equipment is approximately 10% of the initial cost of the equipment (excluding installation) per year.

Energy and Communications

2.6.2.4 An annual sum for the electrical supply to the equipment and also for communications for control and monitoring should be estimated. The cost of energy and communications may well change in real terms over time and it is important to consider this, particularly where different technologies with different costs are being compared. A particular example is where newly installed cables are being compared with leased lines, dial-up or radio systems.

Insurance Repairs

2.6.2.5 Although it is not common practice for Local Authorities to insure street equipment, preferring to take the risk of accidental damage, the money expended by an authority in repairing such damage is an overall cost which can be divided between individual systems in much the same way as an insurance company divides its risk between policy holders by charging an insurance premium. Where possible, the likelihood of damage or loss to equipment should be estimated on the basis of experience and a value for the insurance calculated from an estimated cost of repair for a typical claim, multiplied by the probability of damage occurring in a given year. In areas prone to vandalism, an average value of the cost of repairs due to this cause should be included. Alternatively, for traffic signals, a sum calculated from the average annual expenditure per installation on maintenance not covered by the maintenance contract can be used.

Staff Support

2.6.2.6 Where major systems such as Urban Traffic Control systems are undertaken, there are specific staffing requirements for operation, which need to be included in the analysis. For more minor systems, there is still an increased staff support requirement. All authorities with significant numbers of traffic control installations maintain a specialist staff team (or use external staff) and an increasing number of traffic control installations will naturally require an increase in staff resources. In calculating the costs of staff support, it is important to include overheads as well as salary. This will allow for the costs of increased accommodation and administrative support staff.

2.6.2.7 If a reasonable sum is allocated to this item, it can be taken to cover all redesign work during the life of the project such as the recalculation of signal timings. If it is known that significant redesign will be necessary (because of other nearby systems proposed to be implemented during its lifetime) allowance can be made specifically through a cost assigned to a specific future year.

Replacements

2.6.2.8 During the life of the system certain items may need replacing. It is important to check whether the maintenance estimates include all the replacement requirements. In systems involving computers, it may be necessary to replace computer equipment before the expiry of the economic life of the street equipment. The re-cutting of detector loops is a common requirement for a variety of reasons and local experience should be used to assess what is the realistic average life of detector loops and make an allowance for re-cutting. It should be borne in mind in making the calculation that many instances of loop damage are due to Statutory Undertakers' operations and the costs of repair can be recovered.

Decommissioning

2.6.2.9 Where the life of the scheme is less than the economic life of the equipment, there is some residual value in the equipment. It is reasonable to calculate that residual value as a proportion of its initial cost based on the proportion of its economic life still remaining provided that a realistic estimate of the cost of removing, transporting, refurbishing and storing the equipment is also made. Clearly, if it is near the end of

its economic life, recovery of the equipment may not be worthwhile. Where there is no intention of removing the scheme at the end of the economic life of the equipment, an assessment of residual value and decommissioning costs can be omitted. Omitting residual value is consistent with analysis of road schemes using the programme COBA where the residual value of roads at the end of the COBA analysis period is ignored.

When considering decommissioning costs, the consequences of any current, or proposed, national or European legislation on the disposal of waste materials should be taken into account.

2.6.3 Method

2.6.3.1 The data should be prepared in a table with one row for each year of the analysis. A spreadsheet is a convenient tool for these calculations. Each row should show the year and the costs associated with the various headings, a total cost for the year and the value of that cost discounted back to the present year. The total of the discounted cost column gives the Net Present Cost.

2.6.4 Sensitivity Testing

2.6.4.1 Where a comparison between schemes is being made and future trends in costings are uncertain, possible ranges should be identified for the uncertain costs and the Net Present Cost calculated for each end of the range to see if this affects the ranking of the schemes. If the ranking is changed by the sensitivity test, judgement will have to be made about the most probable future cost pattern.

2.6.5 Worked Example

2.6.5.1 A worked example of a Life Cycle costing exercise is given in Appendix A.

2.7 Concept Design

2.7.1 Introduction

2.7.1.1 The assumed design process starts as concept design, and proceeds through preliminary design to detailed design. The tasks of design will normally be allocated to an individual designer or a team of designers who may change as the design progresses. This three-stage design process may be essential for some systems where a range of solutions may exist. In practice all three stages may not be necessary. It is not a requirement of System Certification that all the stages are separated provided that all design-related decisions are fully documented.

2.7.1.2 'Concept design' refers to the first stages in the life of a scheme when a problem, which could be resolved by a traffic control or information solution, is first identified. The concept could result from an area-wide study or a specific investigation into a problem leading to a range of solutions, not all of which are within the scope of this Code of Practice. Design work to develop a concept into a scheme is then commissioned by the Client.

2.7.1.3 This Code of Practice comes into effect once a traffic control or traffic information system is put forward as a possible solution, and design resources are allocated to the task of preliminary design. The first task of the scheme designer is to establish a definition for the scheme concept containing:

- a description of the problem, preferably quantified;
- the scheme objectives; and
- an outline of one or more solutions.

2.7.1.4 It is possible that the scheme concept will already be completely defined in a design brief. If not, it is the designer's responsibility to complete the definition by agreement with the Client. It is likely that this task will be a requirement of the design organisation's quality assurance procedures.

2.7.1.5 Having defined the scheme concept, it may be possible to assess some of the solutions without further design work, allowing the selection of a more limited range of solutions for further investigation.

2.7.2 Safety

2.7.2.1 Consideration should then be given to any significant impact on safety that is apparent from the known details for each proposal by conducting a preliminary Risk Assessment for the whole life cycle of the schemes from installation through to decommissioning. A brief written record should be made to be incorporated into the preliminary design brief. The following issues should be addressed:

- significant details of the safety history of the site;
- the impact on safety of the proposed solutions;

- the impact on safety of taking no action;
- the conditions of the work site; and
- any specific safety-related objectives of the schemes.

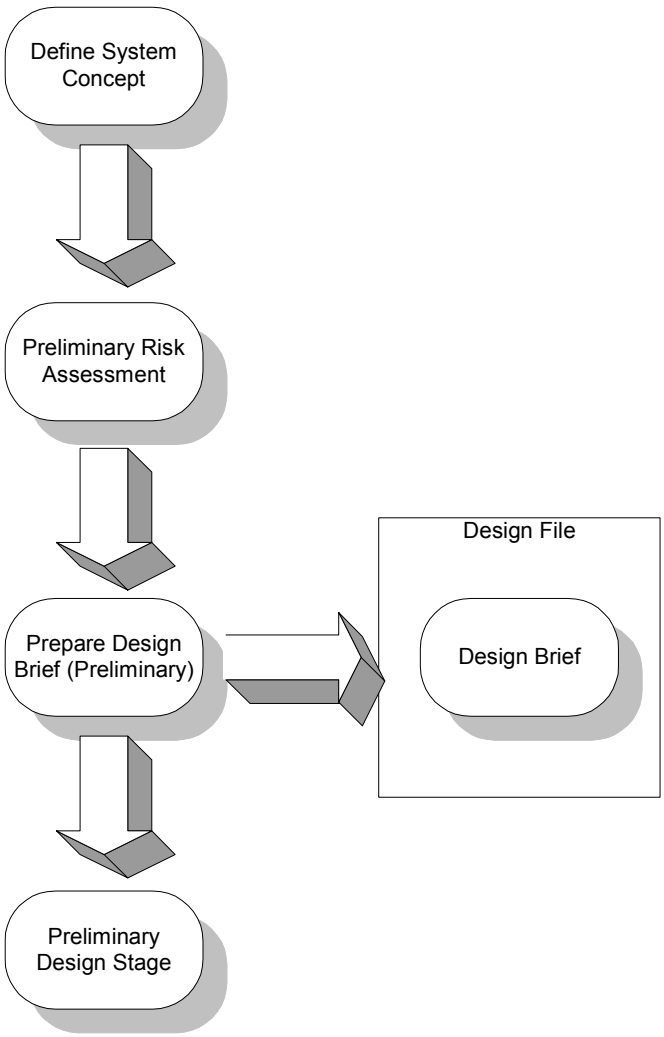

Figure 2-1 Concept Design

2.7.3 Preliminary Design Brief

2.7.3.1 A brief for the preliminary design stage should be compiled containing:

- scheme objectives;
- alternatives to be considered, which will nearly always include taking no action;
- criteria for selection; and
- record of preliminary Risk Assessment.

2.7.3.2 If possible, the brief should include the general method of control and a list of the facilities to be provided for each alternative. Any anticipated requirement for equipment approvals or special signs authorisation should be noted, so that allowance can be made within the design programme. If the scheme concept is sufficiently advanced, it may be possible to consider any requirement for the following:

- traffic regulation orders to restrict traffic movements or parking;
- traffic surveys;
- topographical surveys; and
- public consultation.

2.7.4 The brief may also refer to any design policies set by the client or the design organisation and a project programme and budget.

2.8 Preliminary Design

2.8.1 Introduction

2.8.1.1 Preliminary design takes a scheme concept and develops it in accordance with the preliminary design brief usually by evaluating one or more solutions and producing a layout showing the main principles of the preferred option together with an outline of the method of control.

2.8.2 Surveys

2.8.2.1 A pre-requisite of the design of a traffic control or traffic information system is the availability of adequate traffic data and topographical information. Traffic data may be needed not only for design but also to predict and later monitor the benefit of the proposed scheme.

2.8.2.2 Where the objectives of the scheme are to overcome a defined traffic problem, any description of the existing conditions provided through traffic survey data should be backed up by site visits by the designer to obtain first-hand experience

2.8.2.3 For schemes that entail no significant alteration to road kerb lines, base ordnance survey data may provide sufficient topographical information, but care should be exercised to ensure that the details are both current and accurate. Limited surveys to check certain critical dimensions may be all that is required.

For more significant changes in layout, a full three dimensional model of the existing physical topography may be required. For major changes, early consultation with statutory undertakers who may be affected, is recommended. These consultations may lead to requirement to commission trial excavations to precisely locate existing plant in relation to revised kerb alignments.

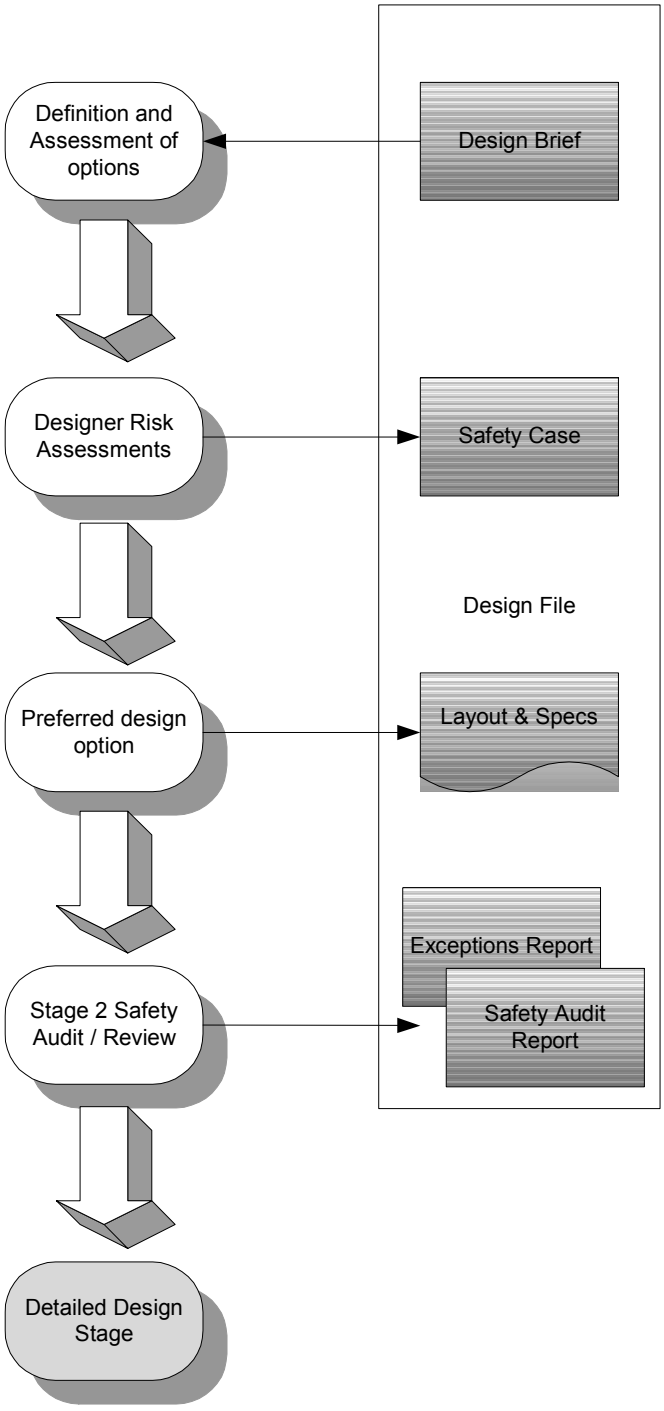

Figure 2-2 Preliminary Design Stage

2.8.3 Definition and Assessment of Options

2.8.3.1 Evaluation of the scheme objectives, alternative design solutions and design constraints will lead to a short list of options and sub-options from which a preferred scheme is to be selected. The design of each option needs to be developed in sufficient detail to allow a budgetary estimate to be prepared, and a prediction of the scheme performance to be made. This normally entails providing a layout at a scale of 1:1250 or larger, together with details of the method of operation. Assessment of alternatives should consider the same factors that are associated with the evaluation of any highway scheme, including:

- safety;
- scheme life cycle costs;
- environmental impact; and
- user and non-user benefits.

2.8.3.2 The evaluation of safety will require a further preliminary Risk Assessment as conducted for the scheme concept, but utilising the additional detail provided through preliminary design.

2.8.3.3 The methodology used to evaluate the scheme benefits will be influenced by the objectives. Techniques for predicting the delays to road traffic at traffic signals are well developed and supported by a range of computer software. Software packages include OSCADY and LINSIG for the analysis of individual signal controlled junctions while TRANSYT can model the delays of a group or network of signals. Other measures of performance, particularly those associated with traffic information systems, are less easy to predict.

2.8.3.4 For the selected scheme it is necessary to demonstrate that there is a net benefit that exceeds the 'do nothing' option. This usually entails a cost benefit analysis which compares the value of benefits produced over the life of the scheme with the life cycle costs, discounted back to the year of installation as discussed in 2.7.

2.8.4 Safety Case

2.8.4.1 A Safety Case should be generated before the scheme develops beyond the Preliminary Design stage, otherwise a proposal may be developed for which, no viable safety case can be maintained. It

should be based on a Risk Assessment of the Preliminary Design documented in a hazard list.

2.8.4.2 The designers should review The Safety Case documentation at the Detailed Design stage. The hazard list should be reviewed as the design changes or is developed in more detail, and the Safety Case should be extended to cover any detailed safety requirements developed as part of the System Requirements Specification.

2.8.5 Safety Review

2.8.5.1 After a preliminary design has been completed, a safety review should be carried out independently of the design team. This review may comprise the Stage 1 Road Safety Audit extended to cover the control and operational aspects of the proposed traffic control or information system, or a standard Road Safety Audit and a separate independent review of the control aspects of the system for traffic control or information being proposed.

2.8.5.2 A copy of the Safety Review report is included in the Design File.

2.8.5.3 The design team should consider the Safety Review report, and where appropriate, introduce changes into the design. All issues raised by the audit require a documented response. Where they have not been accommodated by changes in the design, the reasoning of the design team should be documented in an exceptions report.

2.8.5.4 The Safety Review report with the documented responses, together with any exceptions report, should be incorporated in a revised Safety Case document.

2.8.6 Other Preliminary Design Tasks

2.8.6.1 Other tasks during preliminary design that may be required include:

- advertise Traffic Regulation Orders;
- organise public consultation;
- submit scheme details for equipment approval or special signs authorisation when required;
- consult with police and other groups; and
- check vehicle turning envelopes where kerb lines are changed.

2.8.7 Design File

2.8.7.1 On completion of the preliminary design, the following documents should be assembled to form a Design File:

- preliminary design brief;
- Risk Assessment including hazard list;
- Road Safety Audit and Safety Review Reports; and
- Safety Case document.

2.8.7.2 When a preliminary design is passed to a new team for design in detail, it is necessary to ensure that the Design File is made available to them. To this documentation, it may be helpful to add details on specific detailed design standards set by the client, report on any design issues examined during preliminary design and to highlight any requirements for equipment approvals or special signs authorisation.

2.9 Detailed Design

2.9.1 Introduction

2.9.1.1 Detailed design develops the preliminary design proposals and produces layout drawings for construction and a detailed specification of system requirements.

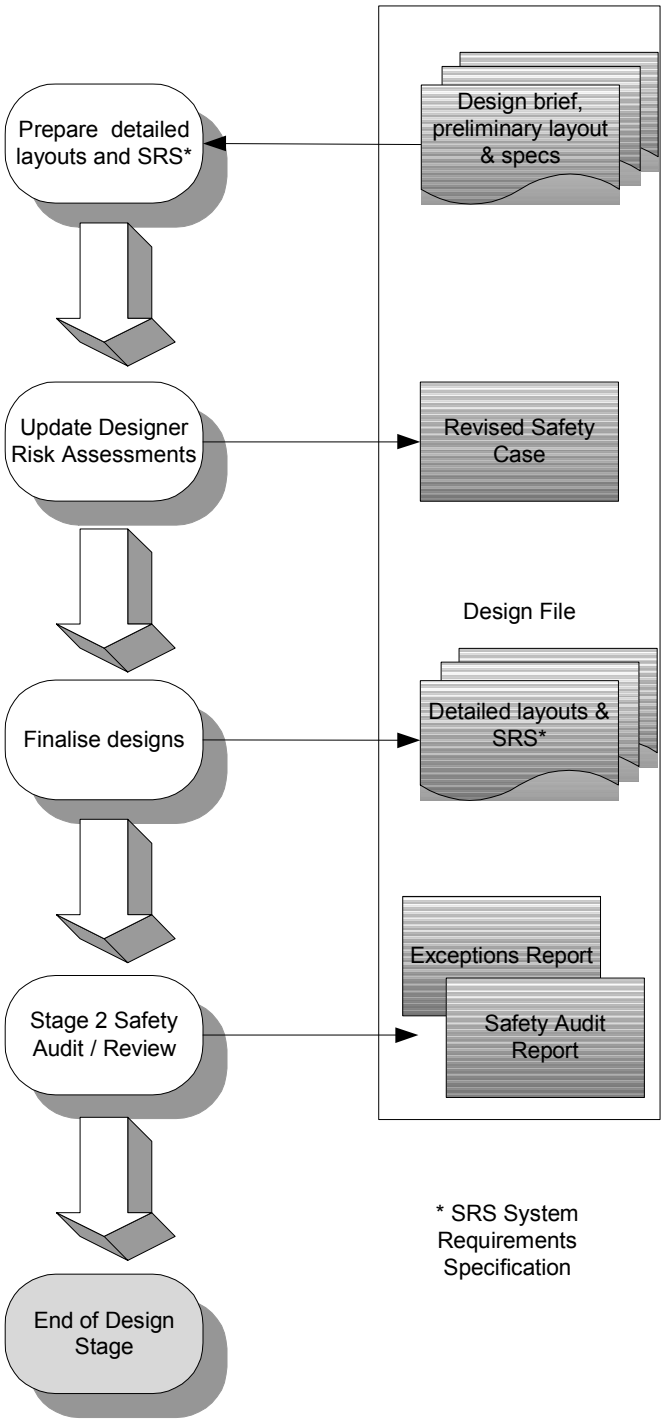

Figure 2-3 Detailed Design Stage

2.9.2 Layout Drawings

2.9.2.1 One or more detailed scheme layout drawings are usually first prepared using a scale of either 1:500 or 1:200 depending on the quantity of information to be incorporated in the drawing. The following details should be defined:

- existing and revised kerb lines;
- type and location of traffic signals and signs;
- type and location of electrically operated barriers and bollards;
- vehicle and pedestrian detectors and push buttons;
- paving details for footways and carriageways;
- road markings, static signs and bollards;
- guard railing;
- location of housings for control equipment and cable jointing; ducting and chambers for cables associated with the traffic control or information system; and
- location of trees or other features that would interfere either with the visibility of signals or signs, or the location of street furniture.

2.9.2.2 The layout drawings form the base for the preparation of a full series of drawings required for construction of all aspects of the scheme which will include some or all of the following details:

- setting out and pavement construction details;
- drainage;
- cabling details;
- location of statutory undertaker's plant;
- street lighting and associated ducts and chambers;
- location of poles and housings;
- landscaping details;
- temporary traffic management during construction and installation;
- detailed requirements for electricity supply and telecommunication services;
- lighting columns;
- bus stops and shelters; and
- existing Traffic Regulation Orders (including parking restrictions).

2.9.3 System Requirements Specification

2.9.3.1 The method of operation for the system defined during preliminary design should be developed into a specification that conveys the designer's intentions fully and unambiguously to the supplier of the system. This task may not involve much detail or complexity, as the scope and level of detail required by the System Requirements Specification (SRS) will vary considerably.

2.9.3.2 For conventional systems based entirely on approved equipment, the SRS may be a list or drawing of the equipment to be installed and a simple description of facilities to be provided. Any programmable aspects of the equipment will need to be defined. For traffic signal installations, the SRS is provided by the controller specification.

2.9.3.3 For innovatory systems that utilise approved equipment in unconventional ways, or which make use of non-approved equipment, greater detail will be required. At the discretion of the Approval Authority for Statutory Approval, it may be a requirement of equipment approval that the SRS is submitted to them for review. An SRS for such systems will contain some or all the following items:

- functional description of the method of operation;
- fault detection and warning systems;
- operation of equipment under defined failure conditions;
- specification for interfaces with other equipment;
- a reliability/availability target to be observed;
- system acceptance testing procedures;
- housing of external equipment;
- accommodation of instation equipment;
- EMC requirements; and
- any special provision for maintenance.

2.9.3.4 When there are alternative types of equipment or systems available to meet the requirements of certain aspects of the system (for example vehicle detection), it may be necessary to examine the relative merits of the alternatives. The costs of operating or maintaining alternative systems throughout the life of the system may differ significantly, and therefore any comparison of costs should consider the full life cycle of the system.

2.9.3.5 The designer of the system or the supplier will be responsible for the electrical design of the system. The SRS should make it clear who is responsible for the work. The relevant organisation will be responsible for signing the design section of the Electrical Completion Certificate, as required by BS 7671.

2.9.4 Revise Safety Case

2.9.4.1 During detailed design, the hazard list should be reviewed and amended as proposals are modified and the operation of the system is defined in detail. This review should address all stages of the system life cycle, including the systems aspects of the construction phase.

2.9.4.2 If the system falls under the specific requirements of the CDM Regulations, a Risk Assessment relating to the construction phase will have been carried out. This Risk Assessment forms part of the Health and Safety Plan, which is a requirement of the designer under the CDM regulations. The 'Client's' obligations under the regulations should also be reviewed at this stage in relation to the appointment of a Planning Supervisor and the preparation of a Health and Safety File.

2.9.4.3 The review should refer to the detailed design drawings and the SRS. Any changes in the risk reduction measures or the safety-related aspects of the scheme since the preliminary design stage should be recorded, together with reasons for the changes. Any special requirements for the preservation of safety during maintenance, operation and eventual decommissioning of the system should also be added to the safety case. Such considerations may lead to a requirement to adapt the normal procedures operated by the organisation responsible for maintenance and operation.

2.9.4.4 At this stage, the designer should check to ensure that any necessary approvals and authorisations from the Secretary of State have been applied for.

2.9.5 Safety Review

2.9.5.1 On completion of detailed design, the design drawings and SRS should be subjected to review by an

independent team. The review parallels the review process carried out at Preliminary Design stage (Section 2.9.5). The review should comprise the Stage 2 Road Safety Audit with the scope extended to consider the operation of the system as defined in the SRS or a standard Road Safety Audit with a separate independent review of the control aspects. The audit team (or the control aspects review team if separate) should include a specialist in the specification of the equipment involved. The review should consider not only the content of the SRS, but also any omissions.

2.9.5.2 For larger projects, it may be sensible to arrange an interim Safety Review to ensure that any contentious issues, which could, for example, affect TROs, are considered early enough to be acted upon.

2.9.5.3 The design team as described in Section 2.9.5 should consider the Safety Review report, and the Safety Case updated.

2.9.6 Other Detailed Design Tasks

2.9.6.1 Other detailed design tasks that may be required include:

- preparation of detailed estimates of costs for supply, installation and system maintenance;
- preparation of standard details and tender documents;
- detail design, including foundations and crash protection and the necessary approvals for mast arms and poles carrying heads above the maximum height prescribed in TSRGD, gantries and other structures;
- preparation of the Health and Safety Plan; and
- determination of system maintenance requirements, and the preparation of a specification for system maintenance procedures.

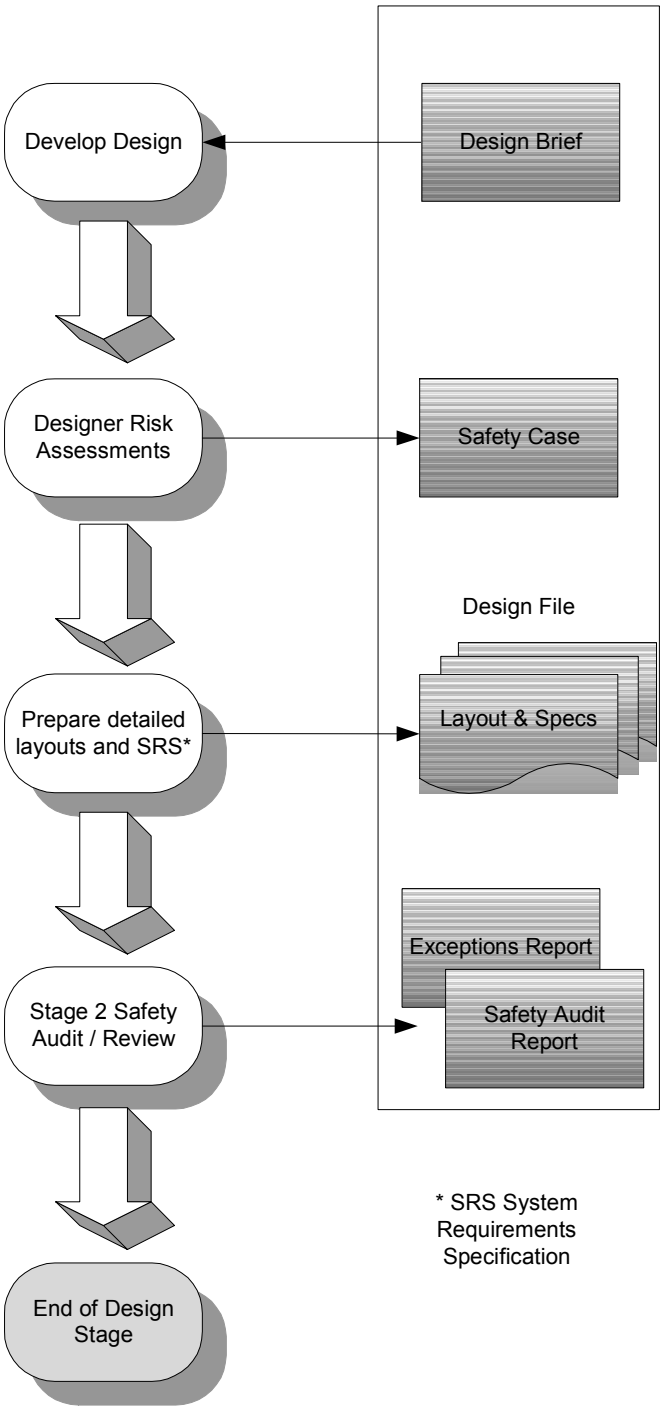

Figure 2-4 Combined Preliminary and Detailed Design

2.10 Combined Preliminary and Detailed Design

2.10.1 There may be situations where there is a need to combine the preliminary and detailed design processes. This will follow the flow diagram as shown:

3. MANUFACTURE AND SUPPLY

3.1 Introduction

3.1.1 This Chapter describes good practice to ensure safety and fitness for purpose to be adopted by manufacturers and suppliers, where manufacture can be taken to include:

- preliminary and detailed design of equipment and software;
- production of equipment and software;
- assembly of equipment and software to form products;
- configuration of products to specific purchaser requirements;
- interconnection of products to form traffic control or information systems; and
- testing of equipment and systems.

3.1.2 Manufacture also includes the assembly of equipment or software supplied by others. Factory testing and site testing of products configured to a purchaser's requirements are considered in this Code of Practice to be part of commissioning and installation, covered in Chapter 4.

3.1.3 The content of this Chapter is not only relevant to manufacturers or suppliers, but also to designers and operators who need to understand how safety is assured in the systems they design and operate, and who may occasionally need to influence this process.

3.1.4 In most traffic control and information systems, equipment with current statutory approvals is utilised in a standard configuration. Items of equipment are developed, tested and manufactured to national specifications appropriate to equipment of the same standard type, and tested in accordance with statutory approval procedures. This process takes place prior to purchase, outside the life cycle of any particular traffic control or information system, and results in type approved products that can later be configured to specific applications.

3.1.5 Subsequent customisation of the equipment takes place after purchase, and consists of the introduction of data, and the configuration and interconnection of hardware to form a complete system. This customisation process is considered in Chapter 4.

3.1.6 Some systems involve the development of new equipment for which there is no current statutory approval, or the use of approved equipment in non-standard configurations. In this situation the manufacturing process is part of the system life cycle, and the purchaser's specification supplements any national type specification that may exist. The procedures recommended for manufacture are the same regardless of whether they are applied to equipment developed to a national type specification or a purchaser's system requirements specification.

3.2 Requirements for Design Authorities

3.2.1 The Department's Statutory Approval procedures require that suppliers who design and manufacture equipment or who carry out modifications have an appropriate quality management system. It is recommended that this system is certified under ISO 9000 by a certification body accredited by the UK Accreditation Service (UKAS) or a European equivalent. The scope of the certification should be relevant to the product being submitted for approval.

3.2.2 It is recommended that purchasers should consider the scope of this requirement to the purchase of any items for which statutory approval is not a requirement.

3.2.3 The supplier's quality procedures should include the activities required by this Code of Practice.

3.2.4 Design authorities should take due account of current and imminent legislation with regard to decommissioning and disposal of redundant equipment.

3.3 Staff Competence and Training

3.3.1 Both management and staff have the responsibility of ensuring that all personnel engaged in product development and manufacture, including suppliers and sub-contractors, are competent to perform the tasks assigned to them. Competence requires:

- having theoretical knowledge and practical experience appropriate to their role;
- awareness of current practice and available technologies;
- familiarity with legislation, regulations and standards; and
- awareness of relevant codes of practice for engineers and managers, e.g. the Institute of Electrical Engineers Safety Related Systems.

3.3.2 Managers should ensure that project teams have the appropriate balance of expertise to undertake the project, covering the full range of disciplines involved. To maintain this balance, they should ensure that opportunities exist for trainees to acquire experience from mature members of the team, and a structured training programme should be provided.

3.4 Product Development Life Cycle

3.4.1 The development process for products intended for traffic control and information systems should be structured in a development life cycle that embodies the safety life cycle specified in BS EN 61508 Functional Safety of Electrical/Electronic/ Programmable Electronic Safety-related Systems. Methods for product development within the life cycle framework should be defined within Company procedures. These methods should take into account the requirements of the statutory approval procedure.

3.4.2 The development process starts from a national specification or a purchaser's requirements specification. These specifications should be reviewed to ensure that their requirements are clear, unambiguous and can be tested. A hazard and risk analysis of the preliminary product design should be carried out, the product's system safety requirements clearly stated and those elements of the system that are safety-related should be identified. (An example of a safety-related system is the green conflict monitor in a traffic signal controller.)

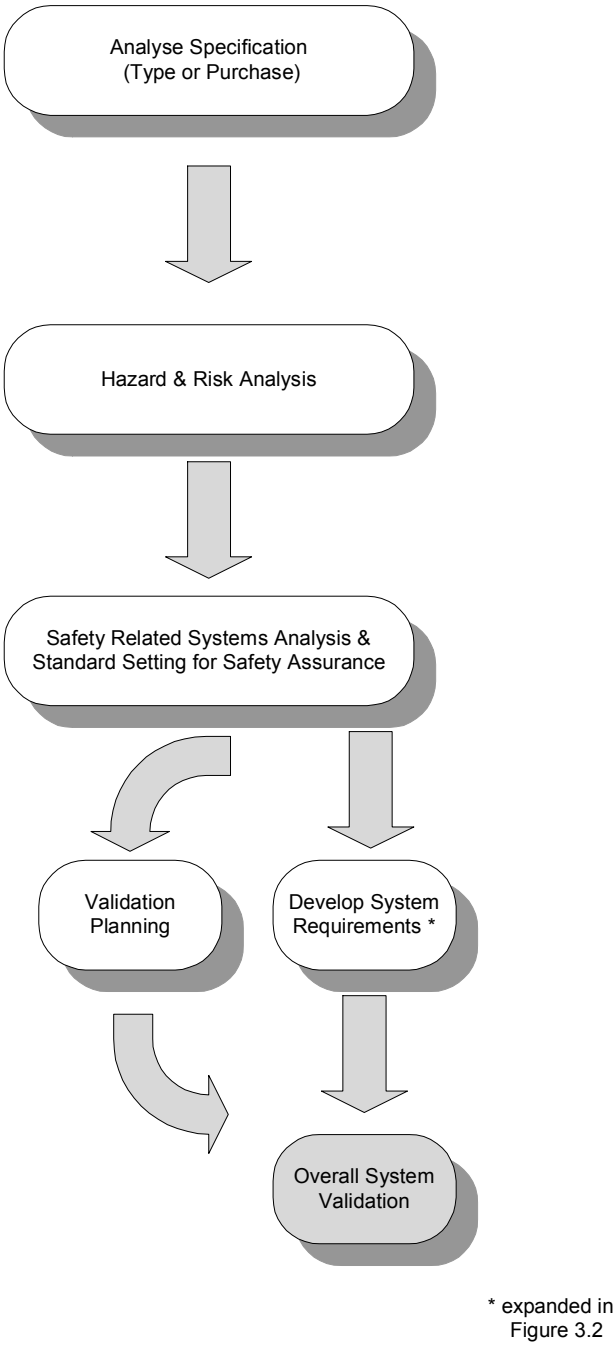

Figure 3-1 Product Development Life Cycle

3.4.3 The required extent of assurance that safety-related systems are safe should be determined with reference to relevant current standards such as BS EN 61508. For software, the assurance requirement can set appropriate targets for availability, reliability and maintainability in product sub-systems where these parameters can be predicted; using appropriate hardware and software design techniques to control the probability of faults and failures; setting standards for testing and the coverage of tests; using appropriate

validation and verification techniques; and setting the degree of independence required of the verification process, with respect to the product design team.

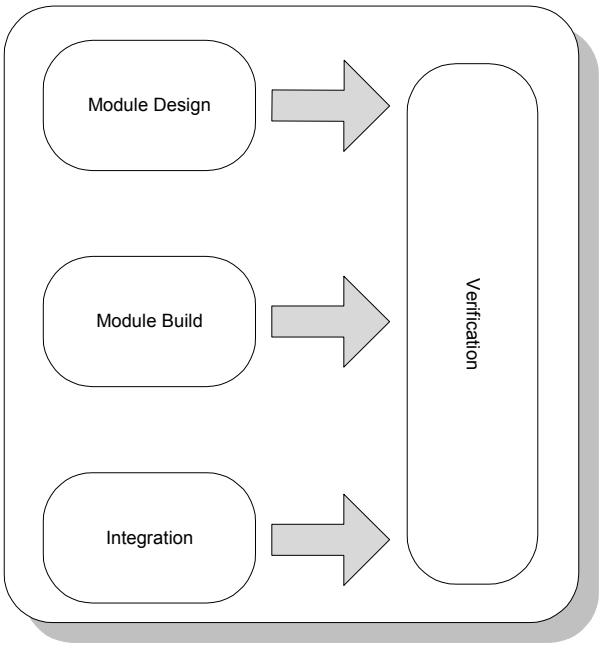

Figure 3-2 Developing System Requirements

3.4.4 Validation of the design of safety-related sub-systems should include an analysis of probabilities and consequences of failure using techniques such as Failure Mode Effects Analysis.

3.4.5 A validation plan should be prepared containing tests or other validation procedures to establish that the finished product meets the initial requirements specification. The plan should take into account any existing products, which may have been previously validated and will not require further tests. The requirements of the statutory approval procedure for environmental and EMC testing by an accredited test house should be accommodated within the plan.

3.4.6 The product system requirements should then be developed starting by partitioning the system into modules using recognised methodologies. The design may need to be developed iteratively in successively greater levels of detail until hardware production drawings and circuit diagrams are produced.

3.4.7 Standards for the production of software coding should be set within the company procedures defining best practice for all languages employed in the product software. Organisations involved in the development or supply of software should operate a Quality Management System capable of meeting the requirements of ISO 9001. The procedures should include measures to verify that the standards have been observed and that others can readily interpret the coding.

3.4.8 When the national specification or the purchaser's specification requires that targets for availability, reliability and maintainability (ARM) are to be modelled or predicted prior to production, then a plan detailing methods and sources of data to be used for prediction and subsequent monitoring should be prepared.

3.4.9 The product's hardware and software modules should be developed and verified through tests designed from a detailed knowledge of the product design and directed towards locating errors. Verification tests should be carried out on modules when they are separate and at various stages of integration.

3.4.10 The product prototype should be tested in accordance with the validation plan to demonstrate the extent to which it meets the type specification or the purchaser's specification. Test procedures for the product development engineers should formulate production units for modules, sub assemblies and integrated systems.

3.5 Legislation

3.5.1 It is important that designers are aware of their specific duties and obligations under current legislation. At the time of writing, legislation applicable to the industry includes:

- The Road Traffic Regulations Act 1984;
- The Traffic Signs Regulations and General Directions 2002 (2002:3113);
- Traffic Signs Regulations (Northern Ireland) 1997;
- The Zebra, Pelican and Puffin Pedestrian Crossings Regulations and General Directions 1997 (1997:2400);
- The Health and Safety at Work etc. Act 1974 (1974 C37);
- The Health and Safety at Work Act (Northern Ireland) Order 1978;
- The Consumer Protection Act 1987 (1987 C43);

- The Electricity at Work Regulations 1989 (SI 1989/635);
- The Electricity at Work (Northern Ireland) Order 1991;
- Building Regulations 1991 (SI 1991/2768 amended by SI 1992/1180);
- Building Regulations (Northern Ireland) 1994;
- Other legislation published after the date of this Code of Practice must also be complied with.

3.6 Legal Liability

3.6.1 Suppliers and Manufacturers should be aware of their liabilities for safety under current civil and criminal law. A summary of some of the legislation is provided in the following paragraphs.

3.6.2 Part 1 of The Consumer Protection Act (1987), which is the UK enactment of an EC directive on Product Liability, makes compensation payable as of right for injury resulting from the failure of a product to be safe, without having to prove negligence.

3.6.3 Under part 2 of the same Act, it is a criminal offence to supply 'any goods ordinarily intended for private use or consumption' which do not comply with the safety requirement for reasonable safety having regard to all the circumstances. The reference to private use or consumption makes this section of the act of limited relevance to traffic control and information systems on public roads.

3.6.4 The Health and Safety at Work etc. Act (1974) places duties in criminal law on manufacturers and suppliers of articles for use in the workplace concerning the safety of the people who use them. It also places responsibilities on manufacturers and suppliers in respect of those people who have to maintain their equipment.

3.6.5 The Sale of Goods Act (1979) defines implied terms to a sale that include fitness for the purpose required by the purchaser when this has been expressed. Most equipment within the scope of this Code of Practice will also be subject to the terms of a contract under which they are supplied.

3.7 Statutory Approval

3.7.1 It is a statutory requirement that certain signs and signals (including associated control equipment) be approved by the Secretary of State before being deployed on UK public Highways. The Highways Agency, at the time of publication of this Code of Practice, undertake UK Approval on behalf of the Secretary of State.

3.7.2 The procedure for obtaining Statutory Approval is defined in the Highways Agency document TRG 0600 – 'Self-Certification Procedures for Statutory Approval of Traffic Control Equipment'.

3.7.3 It is the responsibility of Scheme designers to specify to the supplier that any equipment falling under the categories defined in TRG 0600 should be of an approved type, while the Design Authority (often, but not always the manufacturer) for the equipment has the responsibility to obtain the Approval.

3.7.4 In supply contracts for equipment subject to Statutory Approval, the supplier should be required to supply evidence of the approval status of the equipment and a reference to that evidence should be included in the Design File for all systems using that equipment.

3.7.5 When the Design Authority considers that it has achieved full Conformity with the requirements defined in the appropriate Technical Requirements Specification, a Declaration of Conformity may then be submitted.

3.7.6 This must only be submitted when the Design Authority is satisfied that all the functional requirements have been satisfied, all the required testing has been satisfactorily completed and endorsed, the Product is fit for purpose and the Design Authority accepts the full legal liability for the Product.

3.7.7 Once the Approval Authority is satisfied that the requirements of TRG 0600 have been met in respect of a Declaration of Conformity, a Letter of Acceptance, that grants Approval for the Product to be used on the UK public highways will be issued.

3.7.8 No Product is approved for such use unless the Design Authority is in receipt of such a Letter of Acceptance specific to the Product and its unique product identifier.

3.8 European Directives and CE Marking

3.8.1 It is the supplier's legal responsibility to ensure that all products comply with all relevant European directives. The decision as to which directives are applicable rests with the supplier.

Relevant directives may include:

- Low Voltage Directive;
- EMC Directive;
- Telecom Terminal Equipment Directive;
- Machinery Directive; and
- Safety Directive.

3.8.2 (The scope of the Safety Directive is limited to the safety of system operators or maintainers.)

3.8.3 All new electrical equipment sold in Europe has to be CE marked to show that it complies with all the relevant directives. For some classes of equipment such as terminals to be connected to the public telephone network, type approval by a notified body is required, and the equipment has to be examined by the approval body.

3.8.4 For other products that are fully compliant with the relevant specifications, the supplier can self certify CE compliance. The supplier's procedures should identify individuals responsible for ensuring that the design meets the relevant requirements, and those authorised to sign a declaration of conformity. The procedures should specify the checks required and the evidence that should be prepared before the product can be certified.

3.8.5 When there is not full compliance with the specifications referred to by the directives, information about the product must be submitted to be certified by a competent body appointed by the relevant Approval Authority. It is a legal requirement that this information and other details associated with the certification are retained in a Technical Construction File.

3.8.6 Regardless of whether or not a Technical Construction File is required, the supplier's quality procedures should ensure that documentary evidence of conformity to the EC specifications is retained and can easily be located. The procedures should specify a reasonable period for which the information is to be held. The CE Marking Directive stipulates that certain documentation is retained for a minimum period of ten years.

3.9 Project Management

3.9.1 Manufacturers and suppliers should adopt recognised principles of good practice both in the management of product development and subsequent replication of units, which should be enforced through a quality assurance system. Management procedures should cover both the commercial and engineering aspects of the project.

3.9.2 Before the start of a development project, it is necessary to define the project with reference to the project's objectives, any purchaser requirements, type specifications and legislative requirements. A project plan should also be prepared and developed incorporating:

- a product development programme;
- a product development life cycle;
- a software development plan;
- verification and validation plans;
- review and assessment procedures; and
- change control procedures.

3.9.3 Configuration management procedures should be instigated to ensure that for any item of documentation, software or hardware, its status (current/superseded, tested/untested, original/modified etc.) can be easily ascertained. The effectiveness of such procedures should be monitored.

3.9.4 The safety and reliability performance of production replicas of the development prototype should be controlled and validated through manufacturer's Quality Assurance procedures.

4. INSTALLATION, TESTING AND COMMISSIONING

4.1 General

4.1.1 This Chapter covers the period of the scheme life cycle from after completion of detailed design to bringing the system into operation. Installation includes the implementation of both the civil and electrical engineering aspects of the scheme. Pre-commissioning functional and electrical tests of configured control equipment, signs, signals and cables are carried out separately and with the system fully assembled. Commissioning refers to the final process for bringing the system into operation, checking its functionality in traffic terms and handing it over into maintenance.

4.1.2 Local Transport Note 1/98, The Installation of Traffic Signals and Associated Equipment, recommends good practice for the installation of permanent traffic signals and reference to this document is made throughput this section. Much of the advice given is equally applicable to the installation of all traffic control and information systems, as well as the more conventional signals within its scope. The document covers all aspects of installation work.

4.1.3 Organisations involved in the installation of equipment and cabling for traffic control systems should have an accredited registration for Quality Assurance to ISO9000 with specific reference to the type of work involved. Specialist sub-contractors engaged in slot cutting may be exempt from this requirement but must be adequately supervised by a Quality Assured organisation.

4.1.4 Staff employed in installation, testing and commissioning should be trained and competent for the tasks assigned to them and conversant with the relevant requirements of BS7671 Requirements for Electrical Installations (formerly the IEE Wiring Regulations) and the Electricity at Work Regulations 1989.

4.1.5 Those involved in the supervision of the work and the acceptance of the completed system need to be fully conversant with the functions specified for the equipment and the safety aspects both of the completed system and the installation and commissioning process.

4.1.6 Consideration should be given to the impact and benefits on the life cycle of the system of the appropriate Sector Scheme managed by the Sector Scheme Advisory Committee and promoted by the Highways Agency, Local Highway Authorities and Industry.

4.1.7 The Sector Schemes relate to the quality management system requirements for the installation and maintenance of electrical apparatus and associated structural supports, cabling for highway lighting and traffic signs and the installation and maintenance of traffic control equipment and associated apparatus. It sets out to identify a common interpretation of BS EN ISO 9001: 2000 for Organisations and Certification bodies engaged in the specific sectors of the national highway electrical works to promote safe, consistent and competent working

4.1.8 As a measure of quality management and competency, it is recommended that, where appropriate, Sector Scheme are in existence, then they should be specified in contracts. If specified in the contract, then the provisions of the appropriate sector scheme shall be implemented during installation, testing commissioning and maintenance.

4.2 Statutory Requirements

4.2.1 Major schemes may fall within the special requirements of the CDM regulations whose requirements are summarised in Chapter 2.

4.2.2 Before starting work, the principal contractor is required to produce method statements that describe how risks identified in the Health and Safety Plan are to be overcome.

4.2.3 Other regulations and advice documents that may be relevant are listed below. A summary of their main requirements is given in LTN1/98.

- The Health and Safety at Work, etc. Act 1974;
- The Health and Safety at Work Order (Northern Ireland) 1978;
- Chapter 8 of the Traffic Signs Manual;
- Electricity at Work Regulations 1989;
- Electricity at Work Regulations (NI) 1991;

- The Road Traffic Regulation Act 1984;
- The Road Traffic Regulations (NI) Order 1997;
- The Highways Act 1980;
- The Road (NI) Order 1993;
- The Road Traffic (NI) Order 1993;
- The Disabled Persons Act 1981;
- The Disabled Persons (NI) Order 1982;
- New Roads and Street Works Act 1991;
- Streetworks (NI) Order 1995;
- Avoiding Danger from Underground Services, HSE, 1991;
- BS7671 Requirements for Electrical Installations;
- Other legislation published after the date of this Code of Practice must also be complied with.

4.2.4 The installation of the traffic control system includes both civil engineering and electrical aspects of the system, and will involve different specialists working on site possibly for different contractors or subcontractors or as part of a team undertaking a range of disciplines associated with:

- ducting and road construction;
- traffic control equipment and cabling;
- road markings;
- street lighting;
- signs;
- telecommunication circuits; and
- electricity supplies.

4.2.5 Regardless of the contractual arrangements under which these specialists are engaged, this work needs careful planning and co-ordination.

4.2.6 In particular, the traffic management measures that ensure safe conditions for road users during the installation process need to be carefully monitored. The cutting of detector loops which is a relatively quick operation but which requires the closing of whole traffic lanes is an aspect of installation where traffic management is important but prone to be omitted if not properly supervised. Authorities may consider specifying the employment of a specialist traffic management contractor.

4.2.7 Installation supervisors will need to check that equipment is installed in the correct position and correctly aligned. Cabinet bases and signal poles should be installed as in LTN 1/98 (Chapter 7). Controllers should be aligned so that the doors open as intended.

4.2.8 Planning the installation of schemes that involve the modification of existing traffic control systems should take into account any requirements to maintain safe and adequate control facilities until the modified system is commissioned. Particular attention should be paid to the requirements of pedestrians and vulnerable road users.

4.2.9 For new systems, it is important to ensure that new signs or signals, including road markings, do not give confusing indications to road users before the system is commissioned. To avoid problems, it is advisable to schedule elements such as road marking to be done shortly before the commissioning.

4.2.10 The installation process should ensure that any warning signs connected with the system, such as ‘new traffic signals ahead’ are erected, and, as with traffic signal heads, are covered over until commissioning takes place.

4.2.11 Particular attention is drawn to the safety implications of installation work, the necessity of maintaining signing and barriers to the requirements of Chapter 8 of the Traffic Signs Manual to protect the works, and the need to plan the installation works to minimise disruption and danger to road users.

4.3 Testing

4.3.1 Statutory approved equipment is tested during development and manufacture to ensure that it complies with the relevant national equipment specifications which are not scheme specific, and there is consequently no need to repeat such tests for individual systems. The role of testing in the life cycle of a scheme is therefore to verify that the scheme-specific requirements have been implemented correctly as follows:

- to verify that separate items of equipment have been configured in accordance with the configuration specification;

- to verify the performance of the integrated system, including cabling, interfaces and communication circuits;
- to test electrical cabling and earthing arrangements in accordance with the relevant regulations;
- to verify that the equipment and cabling have been installed correctly through inspection; and
- to carry out specific tests of functions related to safety.

4.3.2 For items not subject to Statutory Approval, the manufacturer's tests will not have been subject to the requirements of the Statutory Approval procedure and it may be necessary for purchasers to consider extending the scope of the testing.

4.3.3 The scope of the system may include not only the local traffic control or information system, but may also include a central monitoring or control system and communications system from the centre to site which will need to be subject to testing.

4.3.4 Tests may be carried out variously by the suppliers, the installation contractors, designers or those responsible for supervision. It is usually a requirement of supply and installation contracts that specified tests are witnessed on behalf of the purchaser during a factory acceptance test (FAT) or site acceptance test (SAT). The extent and scope of such tests will depend on the size and complexity of the traffic control or information system. For simple systems, the FAT may be omitted.

Test to Verify Configuration

4.3.5 For microprocessor-based control equipment, customisation to the specific requirements of the scheme involves the input of configuration data. Testing is essentially a check that the data agrees with the configuration specification and it provides the required method of control. It is recommended that tests are conducted to a previously prepared schedule, but time should be made available for unstructured testing. Particular attention during tests should be paid to input data consisting of logic or special software.

Tests of Completed System

4.3.6 When tests of the integrated system are performed prior to installation, they will normally involve the control system connected to some, but not necessarily all, associated equipment. For complex systems, some items may be simulated by hardware or software representations of their interface with the control system, provided the representation can be shown to be accurate.

4.3.7 A complete integrated test is required for all systems after equipment has been installed, prior to commissioning.

Electrical Cable and Earthing Tests

4.3.8 LTN 1/98 (Chapter 12) lists the tests to be performed and certified on the mains supply, cables and earthing. These tests are requirements of BS7671 and the Specification for Highway Works clause 1217.

Inspection to Verify Correct Installation

4.3.9 An important part of testing is a visual inspection to ensure that the equipment is constructed and installed correctly. The visual inspection should include checking that cabinet door seals and locks are acceptable; cable properly labelled, terminated and bonded; mains supply fuses and cut-outs correctly installed; telecommunications cable properly terminated, and necessary warning labels attached.

Functional Safety Checks

4.3.10 Test and checking procedures should ensure that all safety critical functions are verified. When designing tests to be undertaken at the installation and commissioning stage of the system life cycle, due allowance should be made for the risks inherent in the tests themselves. Product tests previously undertaken by manufacturers and suppliers may have already validated the safety critical functions more effectively than can be achieved on-site. For example, conflict monitor tests on pelican controllers may be unnecessary at installation if the supplier carries out adequate tests during production.

Documentation Requirements

4.3.11 For simple systems, the specification may be used as a checklist of items to be tested. For more complex systems and systems using innovative techniques, test schedules for both the Factory and Site Acceptance Tests should be drawn up. It is common for the Supplier's contract to include the requirements to draw up test schedules for the purchaser's approval. Whether the tests are based on formal test schedules or not, the details of the tests, date, place, time representatives present, functions tested, equipment used and the results obtained should be fully recorded and the records kept in the Design File.

4.3.12 The Contractor who is responsible for the tests should provide an electrical installation completion certificate in accordance with BS 7671. (Note: A competent person should sign these certificates on behalf of the Contractor.) There is also a requirement for the electrical installation design authority to sign confirming their responsibility for the electrical design of the system.

Safety and Signing

4.3.13 Precautions should be taken during site testing to assure safety for road users. Where testing involves obstruction of the carriageway or footway, it is a legal requirement that Chapter 8 of the Traffic Signs Manual be followed. Any potentially misleading signs or indications should be covered. Where this is not practicable, such as when large Variable Message Signs are being tested, steps should be taken to minimise problems (in this example by using test legends which do not mislead and by the use of advance "signs under test" sign boards).

4.3.14 Precautions should also be taken during tests to protect employees from the risk of electrocution and other hazards. Where tests involve an element of risk, a risk analysis should be carried out to identify test methods to minimise risk or to determine whether the test should be carried out.

4.4 Publicity

4.4.1 Where the scheme in operation will require a different response from road users, or affect route choice, it may be necessary to mount a publicity exercise before and after commissioning. For example, temporary signs can be uncovered at commissioning, and used to warn of changes and then left in place for several months.

4.4.2 News coverage through press releases, articles and contacts with radio and television can be useful to warn the public of important changes to the network or the commissioning of major traffic control or information systems.

4.4.3 Official opening ceremonies, if called for, should be carefully planned in conjunction with the police, and occur only when the system is commissioned ready to be switched on. If a benefit of the system is to be an improvement in safety, then it is inadvisable to delay bringing it into operation without good reason.

4.5 Road Safety Audit

4.5.1 After installation and before commissioning, a stage 3 Road Safety Audit as described in HD 19 should be carried out to ensure that all the safety implications of the physical and operational aspects of the system have been fully considered.

4.6 Commissioning

4.6.1 The commissioning of the assembled system follows confirmation that all tests and systems certification procedures have been completed. Details of the procedure are set out in Appendix C.

4.6.2 Before commissioning takes place, the following formal documentation should be checked:

- evidence of equipment approval status;
- factory test completion documentation;
- site test completion documentation; and
- maintenance documentation required on site.

4.6.3 It is unlikely that final as-built documentation will be available at the time of commissioning but, as a minimum, accurate hand-written information should be made available for maintenance. Final documentation should be supplied as soon as possible after commissioning. It is recommended that contracts for installation should stipulate a reasonable time limit for the supply of such documentation.

4.6.4 Verification that all legal procedures, public information exercises and educational programmes have been completed before the scheme is brought into service will be required. It will be necessary to validate the proposals for the successful future operation and maintenance of the system throughout its life cycle by suitably trained and qualified personnel in accordance with fully documented procedures and the technical information, which will be made available to them.

4.6.5 Proper proposals for future modifications to, and the possible decommissioning of, the scheme in a safe and efficient manner should be confirmed.

4.6.6 A final check that all certificates, specifications and drawings are included in the 'Design File' should be made.

4.6.7 The Design File should, as a minimum, include the following:

- final Design Drawings;
- design checklists;
- System Requirements Specification;
- Stage 1, 2 and 3 Road Safety Audit reports;
- details of operational procedures;
- details of maintenance procedures;
- details of modification and decommissioning procedures;
- details of factory and site acceptance tests; and
- System Certification documentation.

4.6.8 The commissioning process brings the new scheme into operation by:

- uncovering signals and signs and switching them on;
- uncovering temporary warning signs;
- completing road markings that have to be omitted until commissioning;
- checking and acceptance of the system by the maintenance body; and
- mobilising publicity.

4.6.9 Commissioning also incorporates testing and monitoring of the system under live conditions to confirm the safe operation of the system.

4.6.10 At this stage, the Overseeing Organisation or a representative gives formal confirmation that the system has been completed in accordance with the contract, and ownership of the system passes from the Contractor to the Overseeing Organisation on signing of a hand-over certificate.

4.7 Monitoring

4.7.1 There should be close monitoring of the operation immediately following commissioning.

4.7.2 A scheme that is properly designed and passed through a Road Safety Audit should not present an additional risk to road users unfamiliar to the area. On the other hand, there is potential for problems for users so familiar with the previous situation that they do not respond to the changes in layout or signing. Depending on the level of this risk, it may be necessary to monitor the system's operation, possibly with continuing police presence, for the hours or days following commissioning.

5. OPERATION AND MAINTENANCE

5.1.1 Introduction

5.1.1 Once a traffic control or information system has been commissioned it is important to ensure that it is operated and maintained in a way that the safety or fitness for purpose introduced during the design and installation process is not compromised during the later stages of the life cycle. Systems are normally operated and maintained by the Highway Authority responsible for the road network on which they are situated, but tasks are often distributed amongst several bodies including contractors and departments employed directly by the Highway Authority.

5.1.2 Operation is taken to include:

- the monitoring and adjustment of systems and their environment;
- the monitoring of the effectiveness of maintenance; and
- tasks associated with manned traffic control centres.

5.1.3 Operation is usually undertaken by staff directly employed by the Highway Authority.

5.1.4 Maintenance consists of the tasks required to ensure that the equipment and cabling continues to operate in accordance with the specifications, and includes routine inspections, replacement of consumable items, fault response and repair. Normally, specialist maintenance contractors are engaged to carry out this work.

5.1.5 A newly installed system is normally subject to the standards and procedures for operation and maintenance that are applied generally to traffic control and information systems by the responsible authority. It is therefore the responsibility of the designer (as discussed in Chapter 2) to design a system that will remain safe under the existing arrangements operated by others. Where a new system involves system maintainers or operators in new areas of expertise, any training requirements should be identified at the design stage.

5.1.6 This Chapter recommends good practice to be adopted in the setting up and management of procedures for operation and maintenance making particular reference to Departmental standards found in TD 24. This document specifies minimum requirements for inspection and maintenance procedures on all-purpose trunk roads but can be taken as guidance for other public roads.

5.1.7 It is not the aim of this Code of Practice to set absolute standards for operation and maintenance.

5.2 Maintenance Organisations and Personnel

5.2.1 It is a requirement of TD 24 that for systems on all-purpose trunk roads, maintenance contractors should be registered under ISO 9002 (Quality Assurance) with a UKAS accredited body for the maintenance of traffic control and communication systems. Specialist sub-contractors engaged in slot cutting, cleaning and lamp changing may be exempt from this requirement, but their activities should be supervised by an organisation registered under ISO 9000. It is recommended that Highway Authorities should consider adopting the same requirements for all classes of roads.

5.2.2 It is important that all personnel involved with the maintenance of traffic control and information systems are suitably qualified and adequately trained on the equipment to be maintained, and this requirement is contained in TD 24. They should also be familiar with the contents of the Electricity at Work Regulations.

5.2.3 As a measure of quality management and competency, it is recommended that all appropriate Sector Schemes are specified in contracts.

5.2.4 Operators may be required to undertake:

- traffic monitoring and adjustment of the traffic control system at the control centre;
- interpretation of fault data from equipment monitoring systems;
- routine management of faults and maintenance contractors; and
- the on site inspection and adjustment of systems.

5.2.5 To carry out these roles effectively, operators need appropriate knowledge of the systems they

operate, and familiarity with the arrangements for maintenance and the terms of maintenance contracts.

5.2.6 Some systems allow for access to specified functions to be restricted through passwords to personnel with appropriate expertise or authority.

5.2.7 Responsibility for identifying and fulfilling personal training needs of maintenance and operator personnel rests both with the individual concerned and the organisation. Particular care is required to ensure that expertise keeps pace with the changing state of the art in the field of traffic control and information equipment.

5.2.8 Formal training for the new and existing item of equipment or systems should form part of the routine of the organisations involved. It is therefore recommended that such organisations should maintain and monitor a training plan for its employees containing targets, time budgets and programmes. Where maintenance or operation is undertaken under contract, the formulation of an agreed plan should be a requirement of the specification and enforced through appropriate penalties upon failure to comply.

5.3 Control Centres

5.3.1 When formulating arrangements for the operation and maintenance of traffic control and information systems, consideration should be given to adopting a single fault control centre for reporting, collating and the clearance of faults. Such a centre will allow operators to set priorities when conflicts occur. Satellite control centres may be added, each with their own link with fault monitoring and management equipment. It is common practice for fault control and the operation of urban traffic control systems to take place within the same control centre.

5.3.2 Computer-based fault management systems assist the management of maintenance by providing a database for recording and tracking the progress of current faults and monitoring routine inspections. These systems also maintain a fault history for each installation, allowing analysis of the fault rates of equipment types. Fault management systems can be linked to remote monitoring and urban traffic control systems for automatic logging of faults.

5.3.3 The hours of manning and number of staff required in control centres will depend on the size and scope of the control and monitoring systems, anticipated requirements for manual intervention, and the presence of CCTV and radio communication systems. When assessing staffing needs it may be worthwhile consulting the system designers, manufacturers and other authorities with similar requirements.

5.3.4 When considering the most effective way of organising operator duties, managers need to remember the health and safety problems associated with extended viewing of computer and television monitors.

5.3.5 Authorities responsible for urban traffic control systems should enforce procedures governing the actions taken by operators to maintain the safe operation of traffic signals. Action plans for specific incidents may need to be developed in conjunction with other agencies such as the police.

5.3.6 Displays showing data derived from the monitoring of equipment or traffic can provide a useful system overview. Displays based on large computer monitors or projection systems are more flexible and easier to update than wall maps.

5.4 Remote Monitoring

5.4.1 Traffic control and information systems can have some of their operational functions monitored remotely by either Remote Monitoring or Urban Traffic Control Systems. Such monitoring is required by TD 24 for traffic control systems on trunk roads with a speed limit of 40 mph or greater, or where the 85th percentile speed is in excess of 35mph.

5.4.2 The design and maintenance of any automated fault monitoring system must in itself ensure that the system has a high availability record. It is recommended that faults in monitoring instations should be treated as urgent.

5.5 Inspections

5.5.1 Procedures for routine site inspections are described in TD 24. Their purpose is to detect operational failure and to identify physical or operational deterioration. The items listed for inspection or test cover:

- equipment operation;
- presence of relevant documentation;
- physical condition of equipment (including mechanical and electrical condition);

- physical condition of signs and road markings;
- vegetation that could obscure signs or signals.

5.5.2 It is usual practice for some if not all the items listed for inspection to be assigned to a maintenance contractor as periodic inspections. Authorities may choose to assign certain items for inspection to different contractors or their own personnel.

5.5.3 Complete inspections are required at least every twelve months with specific items requiring inspections at intervals no greater than six months. The maintenance authority should specify the precise intervals for inspections in procedures and maintenance specifications. It is recommended that some leeway is granted to the contractor. To minimise the risk of exposing equipment to the elements, annual inspections requiring the opening of equipment cabinets should, if possible, be scheduled outside the winter months.

5.5.4 Highway Authorities should take steps to ensure that all inspections are carried out effectively, possible by supplementing the maintenance contractor's inspections with a programme of independent checks. The authority may also need to periodically review the overall operation of an installation to establish that the design and configuration are still appropriate to the circumstances of the site.

5.5.5 It is recommended that all inspections should be recorded during the progress of the inspection on forms comprising a simple checklist and identifying the date, time and individual involved in the inspection.

5.5.6 Inspection procedures should be periodically reviewed to ensure that tests and inspection documentation evolves with changing equipment and technology.

5.6 Monitoring

5.6.1 A pro-active approach to the monitoring of the overall effectiveness of traffic control and information systems is recommended, leading to measures to maintain or improve performance. Feedback resulting from visual monitoring of conditions on site by staff members and the police should be encouraged. Such feedback can be particularly useful for information obtained outside office hours.

5.6.2 The quality of feedback could be maximised by issuing a guide to reporting faults on roadside equipment to official bodies such as the police.

5.6.3 Information from the general public can be encouraged through publicity, notices on street furniture and the provision of a freephone number to accept information.

5.6.4 More formal monitoring is possible through studies of:

- system logs;
- fault records; and
- accident records.

5.6.5 Close liaison between accident monitoring specialists, system operators and designers is recommended. Sharing information between parties may allow the cause of an accident trend to be identified. Sites displaying a particular accident history may warrant special attention on the part of operators and design staff.

5.7 Routine and Non-routine Maintenance

5.7.1 TD 24 (DMRB 8.1) specifies procedures for routine maintenance covering:

- inspection and replacement of electro-mechanical parts;
- bulk lamp changing; and
- lens cleaning.

5.7.2 The standard also lists the requirements for non-routine maintenance. It states that cover should be available on a 24-hour day, 7-day week basis to make safe all defects that present a safety hazard. The standard also gives fault category definitions for trunk roads, but response and repair times are left to the maintenance authority that should define them through their maintenance contract specifications and procedures.

5.7.3 The control of system data by operators should be the subject of quality assurance procedures to ensure that a recent data back up is available at all times ready for re-loading.

5.8 Maintenance Contracts

5.8.1 Tenderers for maintenance contracts should be carefully selected to ensure that only competent organisations are invited to tender. Tenderers should be consulted to establish the time required between award and commencement of contract for mobilisation.

5.8.2 The contract documents should provide a complete description of conditions and working arrangements required by the authority. They should define the contract period, which could be fixed or open.

5.8.3 Maintenance contracts for periods exceeding twelve months will usually contain a price fluctuation clause.

5.8.4 The documents should specify:

- location and inventory of equipment to be maintained;
- fault response periods;
- inspection procedures and periods for inspection;
- penalties for non performance;
- documentation requirements;
- fault reporting procedures.

5.8.5 There should be, within the contract, conditions to ensure that if fault response, inspections and routine maintenance tasks are not carried out within the specified periods, then escalating penalties will be applied. These should be index-linked to the maintenance costs of the overall contract.

5.8.6 Allowance should be made within the contract document for the changeover between maintenance contractors, which may be required either when the contract has run its term or circumstances warrant the premature termination of a contract. It is important that the period of notice to terminate the contract provides a sufficient period to appoint a new contractor and for mobilisation of the new contractor's resources, whilst being sufficiently short to effectively curtail a contract where the contractor's performance has fallen below an acceptable level.

5.8.7 Items requiring replacement during the course of maintenance should be on the principle of like with like, i.e. identical, unless agreed otherwise with the client and be subject to full Departmental approval. When the replacement is not identical, care should be exercised to ensure that the original design intentions are not compromised.

5.8.8 It is recommended that the maintenance contractor is held responsible within the contract for handling and dispatching/receiving all warranty items for repair.

5.8.9 The contract should make provision for regular formal meetings with the contractor's managers, to discuss problems as they arise and review performance. It is recommended that such meetings should take place at intervals no greater than twelve months.

5.9 Documentation

5.9.1 Those responsible for the implementation of maintenance should have access to full documentation and details of each site/system to be maintained. Detail contained in the Design File, assembled through the life of the traffic control equipment, will be the source of this information.

5.9.2 TD 24 requires that there should be records held in the offices of the supervising engineer and the maintenance contractor's depots providing a complete historical record over five years and covering:

- site layout;
- equipment hardware and software;
- configuration data;
- operational settings; and
- fault history.

5.9.3 Documentation that should be available on site includes:

- equipment and cabling layout;
- current control equipment settings;
- site-specific safety instructions; and
- log book detailing maintenance history.

5.9.4 The owner of the equipment is normally responsible for providing the documentation (including log books) for on-site and office use.

5.9.5 Comprehensive records of all faults should be maintained and regularly reviewed to identify repeat faults or abnormal fault frequencies.

5.9.6 There is a legal requirement that records from sealed contracts be kept for a twelve year minimum period and unsealed contracts for a minimum of six years.

5.9.7 The documentation available to operators of traffic control or monitoring systems should include comprehensive manuals covering:

- system operation under normal operating conditions;
- facilities for detecting and diagnosing faults; and
- operator facilities for changing the system configuration.

5.10 Safety

5.10.1 All reasonable steps should be taken to ensure the safety of maintenance personnel and the public during maintenance. TD 24 summarises the statutory requirements for road safety and electrical safety that should be integrated with the maintenance authority's specifications and procedures. These procedures should ensure that site operatives are conversant with good practice necessary to safeguard safety. This legislation includes:

- CDM regulations;
- Health and Safety at Work etc. Act;
- Chapter 8 of the Traffic Signs Manual;
- BS7671; and
- Electricity at Work Regulations.

5.11 Test Equipment

5.11.1 The requirements for the staff of the operating organisation to have access to test equipment should be considered during the design phase. The necessary test equipment, documentation and training should be purchased before the system is brought into operation.

5.11.2 The system maintenance procedures or contracts should cover test equipment including calibration and battery re-charging or replacement.

6. DECOMMISSIONING

6.1 Considerations

6.1.1 When systems are decommissioned, the following need to be considered:

6.1.1.1 Any relevant waste disposal legislation shall be complied with where appropriate.

6.1.1.2 The health and safety of the travelling public, emergency services personnel, maintenance operatives and general public shall be protected at all times.

6.1.1.3 Negative environmental impact should be minimised wherever possible. This includes such considerations as the prevention of ground water or air contamination, the minimisation of greenhouse gas release to atmosphere etc.

6.1.1.4 Care shall be taken to identify any items that contain hazardous substances that are covered by specific handling or disposal legislation. Any items containing such substances shall be handled and/or disposed of in full compliance with the relevant legislation.

6.1.1.5 Item re-use should be considered, provided that safety and functional requirements can be maintained. The financial and environmental costs of item recovery, including removal, transportation, storage, refurbishing and re-installation should be included in this consideration.

6.1.1.6 Where suitable recycling processes are available then these should be considered in preference to unprocessed disposal.

6.1.1.7 The disposal of items via incineration or land-fill should be regarded as the last resort and undertaken in a safe, legal and responsible manner. This may necessitate the use of reputable waste management organisations.

6.1.1.8 Decommissioning operations shall leave any site in a safe, stable and tidy condition. In particular, care should be taken to remove any hazards to humans or the environment and also to remove any items that could be used illegally.

7. REFERENCE DOCUMENTS

7.1 Legislation and Regulations

Building Regulations 2000 (SI 2000 No. 3335)

Building Regulations (Northern Ireland) 2000 (SR 2000 No. 389)

Consumer Protection Act 1987 (1987 C43)

Construction (Design and Management) Regulations (1994) (SI 1994 No. 3140)

Electricity at Work Regulations 1989 (SI 1989 No. 635)

Electricity at Work (Northern Ireland) Order 1991 (SR 1991 No. 13)

European Directives:

- Low voltage
- EMC
- Telecomm Terminal Equipment
- Machinery Directive
- Safety Directive
- CE Marketing Procedure
- Product Liability

Health and Safety at Work etc. Act 1974 (1974 C37)

Health and Safety at Work (Northern Ireland) Order 1978 (SI 1978 No. 1039)

The Disabled Persons Act 1981

The Disabled Persons (Northern Ireland) Order 1982

The Highways Act 1980

The Management of Health and Safety at Work Regulations 1992

The New Roads and Streetworks Act 1991

The Roads (Scotland) Act 1984

The Roads (Northern Ireland) Order 1993 (SI 1993 No. 3160) (N.I. 15)

The Road Traffic (Northern Ireland) Order 1995 (SI 1995 No. 2994) (N.I. 18)

The Road Traffic Regulation Act 1984

The Road Traffic Regulation Order (Northern Ireland) 1997 (SI 1997 No. 276) (N.I. 2)

The Sale of Goods Act (1979 C.54)

The Streetworks (Northern Ireland) Order 1995

The Traffic Signs Regulations and General Directions 2002 (SI 2002 No. 3113)

The Traffic Signs Regulations (Northern Ireland) 1997 (SR 1997 No. 389)

The Zebra, Pelican and Puffin Pedestrian Crossing Regulations and General Directions.1997 (SI 1997 No. 2400)

7.2 Other Notes, Standards and Specifications

BS 7671 Requirements for Electrical Installations (IEE Wiring Regulations, Sixteenth Edition)

BS 6100 Glossary of building and civil engineering terms, subsection 2.4.1 - Highway engineering : 1992

HSE Avoiding Danger from Underground Services

Institution of Electrical Engineers; Safety Related Systems

BS EN 61508 Functional Safety of Electrical/ Electronic/Programmable Electronic safety-related systems

The Traffic Signs Manual

Specification for Highway Works

TRG 0600 – Self-Certification Procedures for Statutory Approval of Traffic Signal Control Equipment

TR 2500 – Specification for Traffic Signal Controller

TR 2507 – Performance Specification for Kerbside Detection Systems for use with Nearside Signals and Demand Units

TR 2504 – Performance Specification for Vehicle Detection Equipment for Vehicle Actuated Portable Traffic

TR 2505 – Performance Specification for Above Ground Vehicle Detector Systems for use at Permanent Traffic Signal Installations

TR 2506 – Performance Specification for Above Ground On-Crossing Pedestrian Detection Systems

TR 2512 – Performance Specification for Below Ground Vehicle Detection Equipment

MCH 1969 – Traffic Control System Design for All Purpose Roads (Compendium of Examples)

The following documents are contained in the Design Manual for Road and Bridges:

TD 7 – Statutory Approval of Traffic Control Equipment (DMRB 8.1.1)

TD 24 – All-Purpose Trunk Roads Inspection and Maintenance of Traffic Signals and Associated Equipment (DMRB 8:1.1)

TD 33 – Use of Variable Message Signs on All-Purpose and Motorway Trunk Roads (DMRB 8.2.2)

TD 50 – The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts (DMRB 6.2.3)

TA 60 – The use of Variable Message Signs on All-Purpose/Motorway Trunk Roads (DMRB 8.2.2)

HD 46 – Quality Management Systems for Highway Design (DMRB 5.2.1)

HD 19 – Road Safety Audit (DMRB 5.2.2)

TA82 – The Installation of Traffic Signal and Associated Equipment (DMRB 8.1.1)

Traffic Advisory Leaflets

TAL10/93 – 'Toucan', an unsegregated crossing for pedestrians and cyclists

TAL5/96 – Further development of advanced stop lines

TAL3/97 – The 'MOVA' Signal Control System

TAL4/97 – Rising Bollards

TAL4/98 – Toucan crossing developments

TAL7/99 – The 'SCOOT' Urban Traffic Control System

TAL8/99 – Urban Safety Management using SafeNET

TAL16/99 – The Use of Above Ground Vehicle Detectors

TAL7/00 – SCOOT Gating

TAL8/00 – Bus Priority in SCOOT

TAL9/00 – SCOOT Estimates of Emissions from Vehicles

TAL1/01 – Puffin Pedestrian Crossings

TAL6/01 – Bus Priority

TAL5/01 – Traffic Calming Bibliography

TAL1/02 – The Installation of Puffin Pedestrian Crossings

TAL2/03 – Signal Control at Junctions on High Speed Roads

TAL3/03 – Equestrian Crossings

TAL5/05 – Pedestrian facilities at Signal-Controlled Junctions (parts 1-4)

TAL1/06 – General Principles of Traffic Control by Light Signals

Traffic Advisory Leaflet – Traffic Light Signals
Relevant Publications

7.3 Addresses

Department for Transport
Traffic Management Division
Great Minster House
76 Marsham Street
London
SW1P 4DR

Highways Agency
5th Floor
123 Buckingham Palace Road
London
SW1W 9HA

Highways Agency
Temple Quay House
2 The Square
Temple Quay
Bristol
BS1 6HA

7.4 Document Sources

7.4.1 The following are available from TSO (Formerly The Stationery Office):

Design Manual for Roads and Bridges
(DMRB documents are downloadable from
www.archive2.official-documents.co.uk/document/
deps/ha/dmrb/)
LTNs,
Regulations,
Acts of Parliament,
Traffic Signs Manual

7.4.2 Department for Transport

Traffic Advisory Leaflets (TALs)
Available to download from www.dft.gov.uk

7.4.3 Highways Agency

TR specifications
MCE, MCH documents
Available to download from www.tssplansregistry.org

7.5 Application Guide for Design Manual for Roads and Bridges and Other Documents

* If appropriate **N** With special requirements for Northern Ireland **S** For use only in Scotland		Traffic Signals			Pedestrian Crossings			VMS Systems	Maintenance	Installation
Document	DMRB Volume	Layout	Timings	Assessments	Layout	Timings	Assessments			
HD19 Road Safety Audits	5	**X**		**X**	**X**		**X**	**X**	**X**	**X**
HD46 Quality Management Systems for Highway Design	5	**X**		**X**	**X**		**X**	**X**	**X**	**X**
SH6 Criteria for Traffic Light Signals at Junctions (Scotland)	8			**S**						
TA15 Pedestrian Facilities at Traffic Signal Installations	8	*	*	**X**						
TA16 General Principles for Control by Traffic Signals	8		**X**	**X**						
TA68 The Assessment and Design of Pedestrian Crossings (i) LTN1/95 The Assessment of Pedestrian Crossings (ii) LTN2/95 The Design of Pedestrian Crossings	8				**X**	**X** **X**	**N** **X** **X**			
TA82 Installation of Traffic Signals and Associated Equipment (LTN1/98)	8									**X**
TA86 Layout of Large Signal Controlled Junctions	6	**X**		**X**						
TA91 Provision for Non-motorised Users	8			**X**			**X**			
TD7 Type Approval of Traffic Control Equipment	8			**X**			**X**	**X**		
TD24 All-Purpose Trunk Roads Inspection and Maintenance of Traffic Signals and Associated Equipment	8							**X**	**X**	
TD33 Use of Variable Message Signs on All-Purpose and Motorway Trunk Roads	8							**X**		
TD35 MOVA System of Traffic Control at Signals	8	*	*							
TD50 The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts	6	**X**								
TA60 The Use of Variable Message Signs on All-Purpose/Motorway Trunk Roads	8							**X**		
TAL4/91 Audible and Tactile Signals at Pelican Crossings		**X**								
TAL5/91 Audible and Tactile Signals at Signal-Controlled Junctions					**X**					
TAL10/93 ‘Toucan’, an unsegregated crossing for pedestrians and cyclists		**X**								
TAL5/96 Further development of advanced stop lines					**X**					
TAL3/97 The ‘MOVA’ Signal Control System		**X**	**X**							

***** If appropriate **N** With special requirements for Northern Ireland **S** For use only in Scotland		Traffic Signals			Pedestrian Crossings			VMS Systems	Maintenance	Installation
Document	DMRB Volume	Layout	Timings	Assessments	Layout	Timings	Assessments			
TAL4/97 Rising Bollards										**X**
TAL4/98 Toucan crossing developments		**X**								
TAL7/99 The 'SCOOT' Urban Traffic Control System				**X**			**X**			
TAL8/99 Urban Safety Management using SafeNET				**X**			**X**			
TAL16/99 The Use of Above Ground Vehicle Detectors									**X**	**X**
TAL6/01 Bus Priority				**X**			**X**			
TAL7/00 SCOOT Gating				**X**			**X**			
TAL8/00 Bus Priority in SCOOT				**X**			**X**			
TAL1/01 Puffin Pedestrian Crossings					**X**	**X**				**X**
TAL1/01 SCOOT Estimates of Emissions from Vehicles				**X**			**X**			
TAL5/01 Traffic Calming Bibliography		**X**			**X**					**X**
TAL1/02 The Installation of Puffin Pedestrian Crossings					**X**	**X**				**X**
TAL 2/03 Signal Control at Junctions on High Speed Roads		**X**	**X**	**X**					**X**	**X**
TAL 3/03 Equestrian Crossings		**X**	**X**	**X**	**X**	**X**	**X**			**X**
TAL5/05 Pedestrian facilities at Signal-Controlled Junctions (parts 1-4)		**X**	**X**	**X**	**X**	**X**	**X**			**X**

8. HISTORY

8.1 Issue of MCH 1969

April 1999

8.2 Issue of TA 84/01 as part of DMRB

February 2001

8.3 Issue of TA 84/06

May 2006

9. ENQUIRIES

All technical enquiries or comments on this Advice Note should be sent in writing as appropriate to:

Chief Highway Engineer
The Highways Agency
123 Buckingham Palace Road
London
SW1W 9HA

G CLARKE
Chief Highway Engineer

Chief Road Engineer
Transport Scotland
Victoria Quay
Edinburgh
EH6 6QQ

J HOWISON
Chief Road Engineer

Chief Highway Engineer
Transport Directorate
Welsh Assembly Government
Llywodraeth Cynulliad Cymru
Crown Buildings
Cardiff
CF10 3NQ

M J A PARKER
Chief Highway Engineer
Transport Directorate

Director of Engineering
The Department for Regional Development
Roads Service Headquarters
Clarence Court
10-18 Adelaide Street
Belfast BT2 8GB

G W ALLISTER
Director of Engineering

APPENDIX A LIFE CYCLE COSTING – WORKED EXAMPLE

A1 Introduction

A1.1 Assume a set of traffic signals with remote monitoring installed as a temporary solution for a period of 7 years. A typical analysis might be prepared as follows. The annual costs are assumed to be incurred at the beginning of each year so the first year's costs are not discounted, the second year's costs are discounted by one year, etc. The decommissioning is carried out at the end of the seventh year and is discounted by the full seven years.

A1.2 The figure taken for annual maintenance includes the costs of regular re-lamping and an allowance for detector replacements as well as the normal contract maintenance. The total amount for maintenance is less than the '10% of initial cost' rule of thumb because a proportion of the initial cost is in non electronic hardware (such as poles and signs) which have a lower maintenance requirement.

A1.3 The Discount Rate used is as advised by the Department for use in COBA. This is currently 6%.

A2 The initial cost is made up of:

Equipment	£20,000
Installation	£ 5,000
Civils work	£25,000
Design costs	£ 4,000
Total	£54,000

Regular annual costs:

Maintenance	£ 700
Energy	£ 300
Comms.	£ 170
'Insurance' Repairs	£ 150
Staff support	£ 300
Total	£1,620

A3 Decommissioning

Cost of removal	£1,000
Residual value	(£5,400)
Total	(£4,400)

A4 Net Present Cost calculation

	Cost	Discounted
Initial	£54,000	£54,000
Year 1	£ 1,620	£ 1,620
Year 2	£ 1,620	£ 1,523
Year 3	£ 1,620	£ 1,431
Year 4	£ 1,620	£ 1,345
Year 5	£ 1,620	£ 1,265
Year 6	£ 1,620	£ 1,189
Year 7	£ 1,620	£ 1,117
Decommissioning	(£4,400)	(£ 2,853)
Net Present Cost		£66,343

The fictional costs quoted above are typical for 2003, but should be regarded as indicative only, as prices can vary greatly by area and contract. Designers should prepare life cycle costings using specific local data.

APPENDIX B GLOSSARY OF STANDARD TERMS

B1 Introduction

B1.1 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.

B2 European Terms

B2.1 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.

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'.

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

B3 Phases and Stages

B3.1 The terms 'phase' and 'stage' often give rise to confusion and misuse. 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.

B3.2 Confusion arises because the term 'phase' is used to express the concept of 'stage' in some other English speaking countries such as Australia and the USA. Furthermore confusion arises from the fact that with simple signals the two terms can often be interchanged without penalty.

B3.3 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'.

B3.4 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.

B3.5 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.

B3.6 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.

B4 Definitions

B4.1 Standard terms used for traffic control are shown below together with their definitions:

Term	Definition
141 form	Configuration forms for a traffic signal controller formerly meeting specification TR 0141 (now superseded by TR 2210). HA reference for these forms is MCH 1827.

Term	Definition
absolute offset	The offset between a signalled junction and a common reference for a controlled area.
acceptance	In this document 'acceptance' relates to the agreement that the System complies with the requirements of this specification and of this Code of Practice. It should not be confused with 'Taking Over' which implies acceptance for contractual or payment purposes.
all-purpose road	Road for the use of all classes of traffic.
all red	A condition of traffic signals where all movements receive a red signal.
all-red period	Period during the change from one phase green to the next when all phases show red.
amber	The particular colour in the yellow part of the spectrum used in traffic signals. The same as the term 'yellow' used in European specifications.
approach	That part of an arm which carries traffic towards the junction.
Approval Authority	The body having delegated powers for the granting of *Statutory Approval* for use on the public highway of traffic control and information equipment (e.g. Secretary of State (DfT) for England, the Scottish Ministers (Transport Scotland) for Scotland).
arm	One of the highways radiating from a junction.
ARM (abbrev.)	Availability, Reliability, Maintainability.
Arrow	A signal aspect with a symbol indicating a direction.

Term	Definition
arterial reversion	Reversion to a selected stage in the absence of demands.
aspect (signal aspect)	A single optical unit, which, when illuminated, displays a single colour or symbol.
audible signal	A device producing a sound to indicate right of way to pedestrians.
availability	The availability of a system is the amount of time the system is functioning and available for operational use expressed as a percentage of the total time.
backing board	A board mounted behind or around a signal head to increase contrast and improve visibility (referred to as 'background screen' in BS EN specifications).
blackout	A period in a pedestrian sequence when neither the red nor the green man symbol is illuminated.
bleep and sweep	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.
bleeper	A device for producing an audible signal.
box sign	A regulatory sign (such as a prohibited movement sign) designed to be mounted alongside a signal head.
bracket	A device for mounting a signal head on to a signal pole.
bus priority	A strategy for reducing delay to buses.

Term	Definition
cabinet	A box installed on-street to contain a controller or other equipment.
cabling	The wiring installed on-street to connect a traffic signal controller with the signal aspects and other equipment.
call	The placing of a demand for a stage or phase.
call/cancel	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.
capacity	The maximum flow that can proceed through a certain point in a given period of time.
carriageway	That part of a road or highway constructed for the use of vehicular traffic.
CCTV	Closed Circuit Television.
CDM	Construction (Design and Management).
CDM Regulations	The Construction (Design and Management) Regulations 1994 (SI 1994 No. 3140).
central reserve	A central island separating the two halves of a dual carriageway.
classified count	A count where flows for different classes of vehicle are recorded separately.
CLF (Cableless Linking Facility)	A system for co-ordinating the timings of signal equipment at adjacent signalled junctions by the use of clocks synchronised to mains supply frequency.

Term	Definition
COBA	Department's computer program for Cost Benefit Analysis.
condition	The pattern of illumination of aspects of a signal head at a point in time.
configurator	A software-based device for preparing the programming for microprocessor-based traffic signal controllers.
conflict	At a junction, movements which cannot proceed at the same time safely are in conflict.
conflicting phases	Phases which control movements which are in conflict (see 'opposing phases').
controller	Apparatus that controls and switches traffic signals.
coordination	An arrangement which relates the timings of the signals at a junction with the timings at neighbouring junction(s).
count	An enumeration of vehicles at a point over a specific time period.
cycle	One complete sequence of the operation of traffic signals.
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.
cycle time	The time taken to complete one cycle.
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.

Term	Definition
demand	Request for right-of-way for traffic passing a detector and approaching a red signal.
demand dependent	A stage in a signal cycle which is only selected when a demand for it is registered.
Department	The Department for Transport (DfT).
Design File	A file of basic information and certification for a scheme, produced during the design process to provide a record of the development of the scheme, the decisions made and the safety considerations.
Design Organisation	The organisation commissioned to undertake the various phases of scheme preparation and supervision of construction. During the course of scheme preparation and construction, the identity of the design organisation may change.
detector	Unit of the vehicular or pedestrian detecting equipment that initiates a demand or extension.
detector loop	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.
detector unit	The part of the detector which is connected to a detector loop or transducer and produces an output when a vehicle is detected.
DfT	Department for Transport.
dimming	The reduction in brightness of signal aspects during hours of darkness to reduce glare to road users.

Term	Definition
Discount Rate	Annual percentage rates used in Cost Benefit Analysis to convert the value of future costs and benefits to present values.
DMRB	Design Manual for Roads and Bridges.
duct box	A chamber installed in the ground which gives access to cable ducts.
ducting	The system of ducts carrying the cabling at a junction.
dummy phase	A software device, within the controller, which may be used to control traffic movements which are not separately signalled. It does not have any associated traffic signals.
duplicate primary signal	A second primary signal mounted on the right hand side of the carriageway.
early cut-off	A condition in which one or more traffic streams, that were running during the preceding stage, are stopped whilst one or more other traffic streams are allowed to continue moving.
early start	An alternative term for ‘late start’.
EC	European Commission.
effective green	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.
EMC	Electromagnetic Compatibility.
exit	At a junction, the portion of an arm which carries traffic away from the junction.

Term	Definition
extension	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.)
Failure Mode Effects Analysis	An analysis of a system, which investigates the possible modes of failure and assesses the effects of such failures.
fall back	The control strategy adopted by a control system when the preferred strategy becomes faulty.
FAT	Factory Acceptance Test.
Fault Management System	A documentation system (usually computer software) for the recording and analysis of the faults reported in a system and the actions taken in response to them.
filter arrow	A green arrow which appears with a red (or amber or red/amber) signal to give right of way to a specific movement.
fixed time	Traffic signal control where the duration of the red and green signals and the length of the cycle is fixed.
flare	The local widening of an approach close to the junction.
flashing	Intermittent operation of a signal aspect.
flow	The rate of passing of vehicles at a point (expressed in pcu or vehicles per hour).
footpath	A way over which the public have a right of way on foot only, not being a footway.

Term	Definition
footway	A way comprised in a highway which also comprises a carriageway over which the public has a right of way on foot.
functional specification	A type of system specification where the functions of the system are specified rather than the method of achieving those functions.
gantry	A frame in the shape of a portal used to mount signs or signals.
gap	The difference in time or space between the back of a vehicle and the front of the following vehicle.
gating	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.
green	The colour of the aspect giving right of way at signals.
green arrow	A symbol incorporated in a green aspect to indicate permitted direction of movement.
green wave	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.
group timer	A device controlling the time periods for a signal group.
guard railing	Railing installed on footways and islands to direct pedestrians to the correct crossing points.
HA	Highways Agency.

Term	Definition
Hazard List	As part of a *Risk Analysis*, a list of features of a scheme which could have an implication for health and safety.
headway	The difference in time or space between the front of a vehicle and the front of the following vehicle.
Health and Safety Plan	A document (as required by the *CDM Regulations)* which contains details of the scheme, an assessment of risks to health and safety to persons involved in, or affected by, the construction of the scheme, and arrangements for ensuring, as far as is reasonably practicable, the health and safety of such persons.
high speed road	A road where the 85th percentile approach speeds at a junction are 35mph (56km/h) or above.
highway	Way over which the public has right to pass. The right may be restricted to specific classes of vehicle.
hood	See 'visor'.
housing	See 'cabinet'.
IEC	International Electrotechnical Commission.
IEE	Institution of Electrical Engineers.
indicative green arrow	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.
intergreen (period)	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.
intergreen matrix	On a vehicle actuated controller, a matrix of intergreen timings between pairs of phases.
interstage period	The period between the end of one stage and the start of the next stage.
invitation period	The period of display of a steady green man to pedestrians at traffic signals.
island	Raised area on the highway, usually at a road junction, shaped and located so as to direct traffic movement.
ISO 9001	One of the ISO 9000 series of international standards concerned with Quality Management and *Quality Assurance* with specific reference to the quality systems where a supplier's capability to design and supply a conforming product needs to be demonstrated.
isolated control	Control of a signalled junction where the timings are not related to neighbouring junctions.
junction	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*.)
lamp	The light source in a signal aspect.
lamp monitoring	A system of checking within a controller that lamps are operating.
lane	A section of an approach marked for the use of a single file of vehicles.

Term	Definition
lane control signals	Overhead signals comprising a downward pointing green arrow and a red cross to indicate the permitted direction of movement on a reversible traffic lane.
lane indication arrows	Road markings in the form of arrows to indicate which traffic movement(s) may use a lane.
late release	An alternative term for 'late start'.
late start	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.
LED	Light Emitting Diode.
lens	The translucent face of a signal aspect which supplies the colour and symbol (if required) and which may control the light distribution of the aspect.
Life Cycle Costing	The costing of a system, including the costs of operation, maintenance and decommissioning, as well as design and construction.
link	In a network, a connection between nodes. In traffic networks, links between junctions may be defined for particular directions, movements or vehicle types.
LINSIG	A computer program for the analysis of isolated traffic signals originally developed in Lincolnshire.
local control	A form of control at a signal installation which is not subject to influences from other junctions or area control systems.
loop detector	A detector which operates by analysing the electromagnetic effects on a buried loop of wire caused by the presence or passage of a vehicle.
loop feeder	Cable connecting a detector loop to its detector unit.
loop tails	The straight ends of the wire forming a loop which are connected to the loop feeder.
lost time	The time during a cycle which cannot be used as effective green to one or more phases.
LTN	Local Transport Note.
mast arm	A pole being curved or having a cantilevered branch to allow a sign or signal to be mounted above a carriageway.
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.
motorway	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.

Term	Definition
MOVA	Microprocessor Optimised Vehicle Actuated strategy based on minimising stops and delays which maximises capacity at a single controlled junction.
movement	The traffic taking a specific route through a junction from a defined entry to a defined exit.
national sequence	The sequence of indications of traffic signals which are prescribed by national legislation or regulation.
Net Present Cost	The costs (both present and future) of a scheme reduced to a single present value in a *Life Cycle Costing* analysis using a *Discount Rate*.
NMCS	National Motorway Communication System.
node	In a traffic network, a junction or other point where it is convenient to identify as the end of a link.
NPC	Net Present Cost.
occupancy (of a detector)	The proportion of time during which a vehicle is determined to be present.
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 oncoming 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.
optical unit	The optical components (lens, lamp, reflector, housing) making a single signal aspect.
OSCADY	A computer program for the analysis of isolated traffic signals developed by the TRL.
overlap	Phases which run in successive stages (e.g. late start, early cut-off).
oversaturation	A traffic condition at traffic signals where demand exceeds capacity.
Overseeing Organisation	Either the Highways Agency, Transport Scotland, the Welsh Assembly Government or the Department for Regional Development (NI), depending on which is responsible for the contract.
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.
pcu	The basic unit of traffic flow equal to the equivalent of a typical car (passenger car unit).
Pelican crossing	A pedestrian crossing using far-side pedestrian indicators with a flashing amber/flashing green man period where vehicles are permitted to move subject to giving way to pedestrians (PEdestrian LIght CONtrolled crossing).
period	A time period in a phase during which there is no change in condition.

Term	Definition
phantom	A false impression that an aspect is illuminated caused by incident light being internally reflected back through the lens.
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.
Planning Supervisor	A nominated person (required under the *CDM Regulations*) whose role is to coordinate and manage health and safety in the design and construction of a scheme.
platoon	A group of vehicles moving together where the behaviour of each vehicle is influenced by the vehicle in front.
platoon dispersion	The tendency for platoons to extend and break up under free running conditions.
pocket	A short additional lane on an approach or within a junction reserved for a specific movement.
pole box	A box installed in the ground at the base of a signal pole to give access to cabling.
portable signal	A traffic signal designed to be moved from place to place.
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.
primary signal	A signal head close to the stop line normally mounted on the left hand side of the carriageway.
PROM	Programmable Read Only Memory.
protected movement	A signalled movement (commonly a right turn) where conflicting movements are held against a red signal.
Puffin crossing	A pedestrian crossing that uses near-side pedestrian signal 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).
Purchaser	The recipient of a product provided by a supplier in a contractual arrangement. This may be the Secretary of State for trunk roads and motorways or the appropriate Highway Authority or the owner of a private road, tunnel or bridge.
push button	A button which may be pressed to register a demand.
push button box	A housing containing a push button. Also 'push button unit'.

Term	Definition
QA	Quality Assurance.
Quality Assurance	A method of assuring that the features and characteristics of a product or service satisfy stated or implied needs.
Quality Plan	A document required under a *Quality Assurance* scheme which defines responsibilities and procedures in a project to ensure that the QA requirements are met.
queue	A stationary or slow-moving file of traffic where the progress of a vehicle is determined by that of the preceding vehicle.
RCD	Residual Current Device.
red	The colour of the aspect giving the instruction to stop.
red/amber	The combination of aspects appearing before green.
red lamp monitoring	Lamp monitoring of some or all of the red lamps at a junction.
reflector	A curved polished device mounted behind a lamp to focus the light through the lens.
refuge	A island where pedestrians may wait.
regulatory sign	A sign indicating a traffic regulation (such as a prohibited movement).
relative offset	The offset between one signalled junction and another.
relay	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.
reliability	A measure of the ability of a system, subsystem or item of equipment to operate without faults usually expressed as the Mean Time Between Failures (MTBF).
remote monitoring	A system installed at a signal controller which checks for faults in operation and reports them automatically to a central point.
reserve capacity	The difference between the capacity of a junction and the current demand (usually expressed as a percentage of the current demand).
Residual Current Device	An electrical safety device which compares the current entering a circuit with the current leaving it and which will isolate the circuit if the difference (the residual current) exceeds a given value.
RFC	A measure of level of use (Ratio of Flow to Capacity).
right of way (at traffic signals)	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)’.
right of way (general)	Right of passage for the public or class of road user (such as footways or cycle tracks). See ‘right of way (at traffic signals)’.

Term	Definition
Risk Assessment	An analysis of the risks to health and safety involved in the construction, operation and maintenance of a scheme. The Risk Assessment included in the *Health and Safety Plan* required by the *CDM Regulations* deals primarily with the construction phase of the scheme. Risk Assessments are also required for the operation and maintenance aspects of a Traffic Control and Information system.
road	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'.)
road marking	Line, symbol or other mark on a road surface to regulate, warn, guide or inform road users.
Road Safety Audit	A formal procedure for the independent evaluation of highway schemes before implementation to identify potential safety hazards which may affect road users and to suggest measures to eliminate or mitigate those problems.
run	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.
SA	Speed Assessment. A VA control strategy for high speed roads which affects the changing of the signals according to the speed of approaching vehicles.

Term	Definition
Safety Case	The formal presentation of evidence that a system will be safe throughout its life cycle. It will include a *Risk Assessment* and will be reviewed at various stages in the life cycle of the scheme.
Safety Review	An independent review of the safety aspects of a system carried out after the preliminary design stage and again after the detailed design stage. These reviews run in parallel with, and may be combined with, the Stage 1 and Stage 2 *Road Safety Audits* extended to cover the control and operational aspects of the proposed system.
SAT	Site Acceptance Test.
saturation flow	The maximum flow (usually expressed in pcu or vehicles per hour) obtained at a stop line during green from a discharging queue.
Scheme	A traffic engineering project which includes one or more Traffic Control and Information Systems.
SCOOT	Split, Cycle, Offset Optimisation Technique which uses real time traffic data to minimise stops and delays for UTC controlled areas.
SDE	Speed Discrimination Equipment. A VA control strategy for high speed roads which discriminates vehicles travelling above a given speed threshold.
secondary signal	A signal beyond the stop line which duplicates the display at the primary signal.
segmented arrow	An arrow signal where the head and shaft of the arrow are separated to improve legibility of the arrow direction.

Term	Definition
serve	A demand is said to be 'served' when the phase to which it relates receives right of way.
shadow	A gap in traffic downstream of a traffic signal caused by the changing of the signals.
shuttle working	A system where signals are used to control a one-way section of carriageway operating in alternating directions.
signal	A dynamic indication presented to road users.
signal display	The combination of illuminated aspects in a signal head which provides a control instruction to traffic.
signal face	One or more signal heads mounted together turned towards a traffic stream.
signal group	A group of signal heads controlled by the same phase.
signal head	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.
signal plan	A set of timings for the control of a group or network of junctions.
signal pole	A pole installed at a traffic signal installation to support one or more signal heads (also 'post' or 'pedestal').
signal sequence	The sequence of displays shown by a signal head.
signals off	A condition of the signals where all signal lamps are switched off.

Term	Definition
signs authorisation	The process of granting authorisation for the use of signs (including traffic signals and road markings) which are not prescribed in the relevant regulations.
solar cell	A light sensitive device mounted on signals to initiate dimming of the lamps during darkness.
solid state relay	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.
split	The division of available green time within a signal cycle between stages.
SRS	System Requirements Specification.
stage	The period within a traffic 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.
stage diagram	A diagram for a signalled controlled junction showing by means of arrows those movements permitted in each of the stages.
start up sequence	The controlled order through which signals progress from the off/standby mode to normal operation.
Starting delay	The time interval between the start of actual green and the start of effective green.

Term	Definition
Statutory Approval	The approval for use on the public highway of the design and construction of an item of equipment produced to meet a Departmental specification and where approval is required under a government statute, which removes the need for individual approval of items of a similar design.
stool	A framework installed below ground on to which a housing is mounted.
stop line	A line on an approach indicating where vehicles should stop.
storage	Ability for vehicles (usually right turning) to wait within the junction.
stream (traffic stream)	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.
stud	A square or circular metallic or thermoplastic marker installed on a road surface to indicate the line of a pedestrian crossing.
SVD	A detector which responds only to certain vehicles identified by their characteristics or by an electronic tag. (Selective Vehicle Detector.)
System	See Traffic Control and Information System.
System Certification	A procedure for recording that the safety-related good practice of this Code of Practice has been followed for an individual system.

Term	Definition
System Certifier	Either the Purchaser or a nominated person who, on behalf of the Purchaser, monitors the progress of the design, manufacture and installation of the System with particular regard to the stages outlined in this Code of Practice relating to safety in design.
System Requirements Specification	A detailed statement of the requirements of a system produced during the design process, which will form the Functional Specification for the manufacturer of the system.
tactile indicator	An indicator (typically a rotating cone) which indicates the presence of a green signal for the benefit of visually impaired pedestrians.
tactile paving	A type of textured paving which can be identified by visually impaired pedestrians to indicate the location of a pedestrian crossing facility.
Technical Construction File	A file containing information about a product submitted to the relevant government authority for approval for CE marking where the product does not fully comply with the specifications referred to by the directives and consequently cannot be self-certified by the supplier.
temporary signal	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).
terminal	A device which can be connected to a controller (or other equipment) to allow information to be input or extracted.

Term	Definition
time-distance diagram	A diagram for a linear system of traffic signals showing the signalled junctions' locations on the 'distance' axis and the main road signal sequences on the 'time' axis. This can be used to design and examine 'green wave' timings.
time table	In a coordinated traffic signal system, a list of times and days when control events (such as plan changes) take place.
Toucan crossing	A stand-alone combined pedestrian/cyclist crossing.
Traffic Control and Information System	An assembly of electrical and mechanical units, controlled by electronic hardware, firmware and/or software which may include specific modules such as detectors, actuating, informatic and signalling equipment configured in such a way as to provide a facility for controlling or giving information to road users.
tram signal	A signal which controls Light Rail Vehicles running on-street at signalled junctions.
TRANSYT	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.)
Trial Assessment	The use of equipment under a temporary and limited approval granted by the *Approval Authority* to allow assessment of new or modified equipment prior to pursuing full *Statutory Approval.*
TRL	Transport Research Laboratory.
trunk road	A road of national importance administered by central government.
UKAS	United Kingdom Accreditation Service.
Unique product identifier	Code or type number which clearly defines a product.
Urban Traffic Control System	A system for the central control of electronic traffic control devices in a defined area, which will usually comprise primarily, but not necessarily exclusively, traffic signal installations.
UTC	Urban Traffic Control. A method of controlling and managing a number of traffic signals from one computer system.
variable maximum green	A feature of vehicle actuated control which allows the maximum green timing to be varied according to traffic flow.
variable message sign	A sign with a legend which can be varied.
variable minimum green	A feature of vehicle actuated control which allows the minimum green timing to be varied according to traffic flow.
vehicle actuation	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.

Term	Definition
Visor	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).
wait indicator	An illuminated panel in a pedestrian push button box which indicates that a demand has been registered.
walk with traffic	A control system where pedestrian phases run with non-conflicting vehicle phases.
washout	The reduced contrast between an illuminated aspect and its background caused by the non-specular reflection of incident light on the lens.
Webster	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.
wig wag	A signal having two similar aspects which are illuminated alternately.
Y	The sum of the y values of the critical traffic stream of each stage for all the stages in the cycle.
y value	The ratio of demand and saturation flow for a traffic stream.
yellow	See 'amber'.

APPENDIX C SYSTEM CERTIFICATION PROCEDURE

C1 Overview

C1.1 This system certification procedure specification was previously issued as MCH 1813 and included as an annex to TA 84/01. It has been produced to assist highway and road authorities, consultants and contractors who design and implement non-motorway traffic control and information systems. The main aims being to promote safety and consistency through good design practice. This specification is to be used in conjunction with this Code of Practice for Traffic Control and Information Systems for all-purpose roads.

C2 Introduction

C2.1 This specification sets out a system certification procedure for the design and installation of traffic control and information systems. The parties involved include, but are not limited to, system designers, purchasers, installers and commissioners.

C2.2 This specification should be read in conjunction with the main sections of this Code of Practice. System Certification demonstrates compliance with this Code of Practice and provides a formal declaration that all reasonable and practicable steps have been considered at each stage in the design of a system to ensure that the safety of the road user and other parties is not prejudiced.

C2.3 It is recommended that this specification is used as an 'aide-memoir' procedure under which highway authorities can record that they have followed the parts of this Code of Practice relevant to them. However, should it be decided that full system certification is to be pursued, then a number of fundamental requirements that are mandatory within the Code (see Chapter 2) will need to be satisfied before the document can be fully authorised.

C2.4 This specification contains general information and specific advice for the completion of the system certificate and the system certification records.

C2.5 Certification of the system should not be regarded as certifying the overall scheme, which may contain elements other than the system itself. The certification applies only to an individual system in its scheme context and does not represent a form of type approval for similar systems used in other schemes.

C2.6 System Certification is not a replacement for Statutory Approval, which is still required for all relevant items of equipment forming part of the system.

C2.7 In any scheme contract or close working relationships with other parties involved in the design and development of the system, it is recommended that reference to System Certification and documentation is made along with the requirement to comply with the certification procedures and to follow the guidance given in this Code of Practice.

C2.8 It is also recommended that the System Certification procedure be incorporated into the ISO 9000 quality assurance procedures being adopted by the various parties involved in the scheme. This will include, but not be limited to, the purchasing, designing, manufacturing and installing organisations.

C3 System Certification Procedure

The System Certifier

C3.1 The System Certification procedure is intended to certify that the system has been designed, installed and commissioned in accordance with this Code of Practice. In signing the Certificate, the Certifier confirms that the processes required by this Code of Practice have been carried out (including other requirements implied by this Code of Practice such as Health and Safety Act requirements, CDM Regulations where applicable and Road Safety Audits). It does not imply that the Certifier has personally checked all the safety-related aspects of the design.

C3.2 Consequently, the System Certifier should be a person who is in a position to know what procedures have been carried out, knowledgeable enough to understand the technical implications of those procedures and with sufficient authority to ensure that they are carried out. This person would normally be the Project Manager or other person responsible for managing the systems aspects of the scheme. It would not normally be a departmental head or chief officer

unless they had a direct management role in the scheme.

C3.3 This level of responsibility assumes that the nominated System Certifier will in turn ensure that all other nominated personnel involved in the scheme are competent and have the appropriate skills to perform the tasks being undertaken. This is particularly important where he/she may have to rely on these personnel for verification that each stage of the certification procedure has been satisfactorily addressed.

C3.4 Where the design work is carried out by a different organisation from that carrying out the installation and commissioning, it is possible to have separate System Certifiers for each part of the work. This would require the System Certificate form to be modified to indicate the section of the work that is being certified, but all the certifiers should sign on the same form to produce a single certificate for the installed system.

C3.5 This procedure can be useful when the design is prepared but the installation is deferred for some reason, or when a consultant prepares a design but a local authority manages installation and commissioning.

The System Certificate

C3.6 The system certificate (page C/4), when completed and authorised, represents formal certification of the system. Other forms are included to assist the project manager or System Certifier as an 'aide-memoir' in order to keep track of the stages of the project and to provide a continuous record of progress.

C3.7 The use of these forms is optional but some arrangement must be provided for the proper documentation of the various stages of the design and implementation process. These stages shall be considered to be 'hold points' in the overall system certification procedure and continuation beyond these points only occurs when the specific procedures have been properly addressed, as confirmed by completion of the appropriate parts of the record forms or equivalent documentation.

C3.8 Although the completion of the forms is optional, the procedures that they are associated with will have to be fully addressed to meet the minimum requirements set out in this Code of Practice before a System Certification can be signed.

C4 Scheme Information and System Acceptance Certificate

C4.1 This form is divided into two parts. The first identifies and records the location details of the scheme and provides a reference to the System Requirements Specification (SRS) and the Design File. The second part of this form is the acceptance certificate which, when signed, provides confirmation that the design of the system has been undertaken in conformity with this Code of Practice.

Scheme Title

C4.2 This entry will be a single sentence describing the common name or title of the scheme. For example, it may read, 'Newfoundland Road/Houlton Street signalised junction, Bristol'.

Reference Number

C4.3 The number that is entered here will be a unique number to the scheme and should only be quoted specifically as an identifying reference to the scheme title and the site address. For example, the reference number may be the 'As Built' drawing number which is directly associated with the site of the installation.

Expected Completion Date

C4.4 The entry in this box is the date when the Installation is expected to have received its final commissioning, made live to traffic and handed over to the maintenance organisation.

Description of the Scheme

C4.5 In this box a brief description of the scheme will be entered to inform the reader the purpose of the installation, which will further identify the scheme being certified.

Site Address

C4.6 The entry in this box will be the specific address or addresses of the scheme. It is possible that a scheme could encompass more than one specific installation site and may cover an interconnected traffic area.

System Requirement Specification Reference

C4.7 This box contains a reference for the document representing the System Requirements Specification. For conventional installations, using approved equipment, this may only be a list of the type of equipment being employed or a drawing reference together with a brief summary of the method of operation. If the installation is non-conventional, a more detailed SRS document will be required.

C4.8 Any reviews or amendments that the SRS may have been subjected to during the design stages should be referred to in this box.

Design File Reference

C4.9 If the Design File is a structured document or a software file representing the supporting design documents, the entry in this box could be limited to a simple reference number/descriptor through which the reader can access any information recorded during the design life cycle.

C4.10 However, if the file is an assembly of non-collated documents then the reference number/ descriptor of each document will need to be included.

Completion Date

C4.11 The completion date is the actual date that the scheme had received its final commissioning, was made live to the traffic and handed over to the maintenance organisation. This date may not necessarily be the same as the Expected Completion Date or the date on which the system certificate is issued.

C5 Stage Record Forms

C5.1 Forms for recording the progress of the certification process can be found at pages C/5-C/8. The use of these forms is optional but they do provide a useful guide to the type of records which are required for certification.

C5.2 These forms are divided into a table with seven columns. The rows refer to the important ‘milestone’ items and documents. The seven columns refer to the identification and audit trail of the items of information.

C6 Sample Certificate

SYSTEM CERTIFICATION
SCHEME INFORMATION AND SYSTEM ACCEPTANCE CERTIFICATE

SCHEME TITLE		REFERENCE NUMBER	
		EXPECTED COMPLETION DATE	
DESCRIPTION OF THE SCHEME			
SITE ADDRESS(ES)			
SYSTEM REQUIREMENTS SPECIFICATION			
REFERENCE AND LOCATION OF DESIGN FILE		COMPLETION DATE	

HIGHWAY AUTHORITY		CONTACT	
SYSTEM CERTIFIER		REPRESENTING	
SYSTEM CERTIFICATION DECLARATION	I CERTIFY THAT THE SYSTEM HAS BEEN DESIGNED, INSTALLED AND COMMISSIONED IN ACCORDANCE WITH THIS CODE OF PRACTICE FOR TRAFFIC CONTROL AND INFORMATION SYSTEMS		
SYSTEM CERTIFIER'S SIGNATURE			

C7 Sample Preliminary Design Stage Document

SYSTEM CERTIFICATION RECORD – PRELIMINARY DESIGN STAGE

SCHEME TITLE		REFERENCE NUMBER	

ITEM	TITLE AND DESCRIPTION	REFERENCE NUMBER	AUTHORISED BY	DATE AUTHORISED	ORGANISATION	FILE REFERENCE	FILE LOCATION
PRELIMINARY DESIGN BRIEF							
PRELIMINARY LAYOUT DRAWINGS							
RECORD OF NAMES AND COMPETENCE OF DESIGNERS							
SAFETY CASE (INCORPORATING HAZARD LIST)							
SAFETY REVIEW Stage 1 Road Safety Audit Stage1 Eexceptions Report System Review							

C8 Sample Detailed Design Stage Document

SYSTEM CERTIFICATION RECORD – DETAILED DESIGN STAGE

SCHEME TITLE		REFERENCE NUMBER	

ITEM	TITLE AND DESCRIPTION	REFERENCE NUMBER	AUTHORISED BY	DATE AUTHORISED	ORGANISATION	FILE REFERENCE	FILE LOCATION
DETAILED DESIGN BRIEF							
DETAILED LAYOUT DRAWINGS							
RECORD OF NAMES AND COMPETENCE OF DESIGNERS							
TYPE APPROVAL REQUIREMENTS SPECIFIED							
SYSTEM REQUIREMENTS SPECIFICATION							
SIGNS AUTHORISATION Applied for: Granted:							
SAFETY CASE REVIEW							
CDM PLAN PREPARED							
SAFETY REVIEW Stage 2 Road Safety Audit Stage 2 Exception Report System Review							

C9 Sample Manufacture and Design Stage Document

SYSTEM CERTIFICATION RECORD – MANUFACTURE AND SUPPLY STAGE

SCHEME TITLE		REFERENCE NUMBER	

ITEM	TITLE AND DESCRIPTION	REFERENCE NUMBER	AUTHORISED BY	DATE AUTHORISED	ORGANISATION	FILE REFERENCE	FILE LOCATION
EQUIPMENT FUNCTIONAL SPECIFICATION FOR SPECIAL SYSTEMS							
EQUIPMENT STATUTORY TYPE APPROVAL							
QUALITY ASSURANCE							
PRODUCT CONFORMITY							

C10 Sample Installation and Commissioning Stage Document

SYSTEM CERTIFICATION RECORD – INSTALLATION AND COMMISSIONING STAGE

SCHEME TITLE		REFERENCE NUMBER	

ITEM	TITLE AND DESCRIPTION	REFERENCE NUMBER	AUTHORISED BY	DATE AUTHORISED	ORGANISATION	FILE REFERENCE	FILE LOCATION
NAMES AND COMPETENCE OF SUPERVISION PERSONNEL							
CONTRACTOR COMPETENCE							
EVIDENCE OF EQUIPMENT STATUTORY TYPE APPROVAL							
FACTORY TESTS TESTER NAME/ COMPETENCE Test schedules and results							
FUNCTIONAL TESTS AND INSPECTIONS TEST NAME/ COMPETENCE Site check sheets							